Twenty-Sixth Annual Report
of the
Ontario Bureau of Mines
1917

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TWENTY-SIXTH ANNUAL REPORT

OF THE

ONTARIO BUREAU OF MINES, 1917,

BEING

VOL. XXVI.

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1917

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LETTER OF TRANSMISSION

To His Honour Sir John Strathearn Hendrie, C.V.O.,

Lieutenant-Governor of the Province of Ontario.

Sir,—I have the honour to transmit herewith, for presentation to the Legislative Assembly of the Province of Ontario, the Twenty-sixth Annual Report of the Bureau of Mines.

I have the honour to be, Sir,

Your obedient servant,

G. H. Ferguson,

Minister of Lands, Forests and Mines.

Department of Lands, Forests and Mines,
Toronto, 1917.

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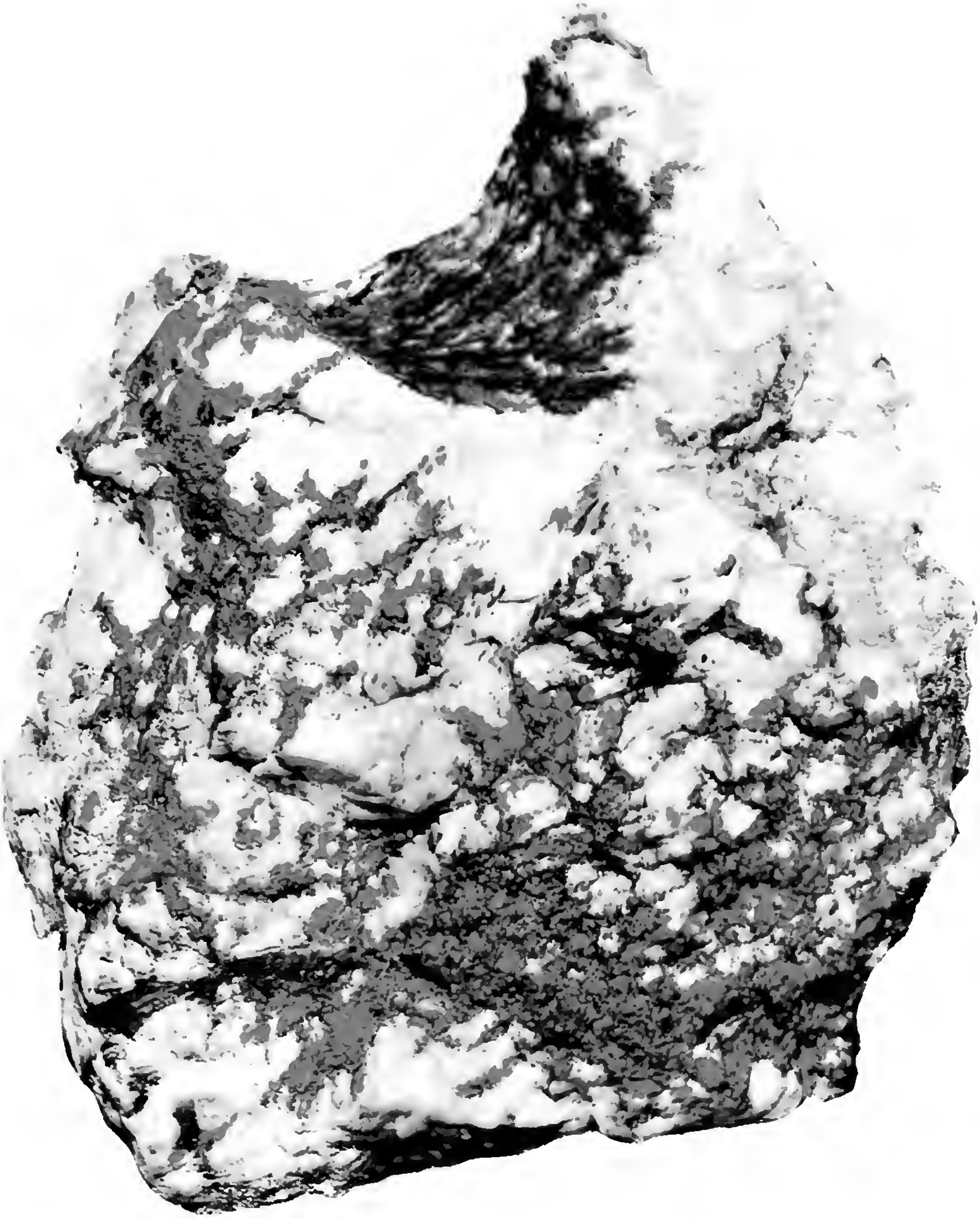

SPECIMEN OF GOLD QUARTZ (ACTUAL SIZE) FROM CROESUS MINE
MUNRO TOWNSHIP, NORTHERN ONTARIO

Note drill hole in upper part of illustration. The ore is over one-third gold

INTRODUCTORY LETTER

To The Honourable George Howard Ferguson, K.C.,

Minister of Lands, Forests and Mines.

Sir,—I beg to submit to you herewith, for transmission to His Honour the Lieutenant-Governor in Council, the Twenty-sixth Annual Report of the Bureau of Mines, being for the calendar year 1916.

The Report opens with a statistical review of the mining industry of Ontario for the year, which was one of great activity, particularly in the mining of metals. The products of the mines and mineral works had a total value of upwards of sixty-five millions of dollars, showing an increase over the output of 1915 of more than eleven million dollars, or twenty per cent., and being the largest total yet recorded.

This is followed by a chapter on the Mining Accidents of the year by T. F. Sutherland, Chief Inspector of Mines, and by a description of the operating Mines of Ontario by Mr. Sutherland and the inspecting staff, showing the work done at the mines during 1916, and their condition at the close of the year, or latest date of inspection.

M. B. Baker gives an account of the Long Lake gold mine, Sudbury district, which is of interest because of the isolated position of this mine, not being in a recognized gold "camp"; and also records his observations on the Alexo Nickel Mine in the township of Dundonald, which occupies a similar relation to the well-known nickel area of Sudbury, from which it is 130 miles distant.

The Dryden Gold Area, by Ellis Thomson; the Kowkash Gold Area, by P. E. Hopkins; Gold-bearing Veins in Benoit Township, and Gold in Gauthier Township, by A. G. Burrows, give an idea of the conditions in these several localities, some or all of which contain the promise of gold production in the future.

A. G. Burrows examined the unsurveyed territory along the line of the Canadian Northern Ontario railway east of Lake Nipigon from Longuelac to Jellicoe and Orient Bay, and gives the results of his explorations in a chapter under that title.

Molybdenite is a mineral which has taken on a considerable degree of importance since the war began, because of its usefulness as an alloy of steel and in the making of special metal for high speed tools. In last year's Report a list of the Ontario occurrences was given by A. L. Parsons, and in the present volume that gentleman presents a description of these deposits in greater detail.

An interesting deposit of the rare mineral euxenite, in the township of South Sherbrooke, is the subject of a short chapter by W. G. Miller and C. W. Knight. Euxenite is of importance as containing a considerable proportion of uranium, and so constituting a source of radium. It is to be regretted that the indications regarding the quantity of this mineral do not point to the existence of a workable supply. Hitherto the chief sources of radium have been pitchblende and autunite

in Europe, and carnotite in the United States. It is estimated that euxenite concentrate carrying, say, 10.5 per cent. of U_3O_8 would be worth about $500 per ton.

The closing chapter of the Report, by W. G. Miller, deals with Lateric Ore Deposits. Lateric ore bodies are practically unknown in Ontario, where glacial erosion has been so severe, but in many other parts of the world this method of ore occurrence is of much importance. In view of the magnitude of the Ontario nickel industry, where the nature and relationships of the ore bodies are of an entirely different character, the lateric type of ore occurrence is of much interest, because of the fact that the New Caledonia deposits are of this nature, as well as the extensive beds of nickeliferous iron ore in Cuba.

Mention should be made of the staff of the Bureau of Mines, which has not been laggard in the defence of the cause of freedom and justice at stake in the present tremendous conflict. Sergeant A. G. Scovell, Clerk, enlisted in 1914 with the first Canadian contingent; Lieutenant J. G. McMillan in 1915, and Lieutenant James Bartlett in 1916, Assistant Inspectors of Mines, both joined the Tunnelling corps. Capt. Albert Skill, Mining Recorder at Elk Lake, and Private H. E. Sheppard, Mining Recorder at Gowganda, also enlisted, the former in 1915 and the latter in 1916. Private W. J. Bell, cartographer, enrolled himself as a cyclist in 1915. They have one and all worthily maintained the honour of Canada. Lieut. McMillan was promoted to be captain, and by his gallant conduct won the Military Cross. Private Bell was invalided home in 1916, and Capt. Skill was killed in action in October, 1917.

I have the honour to be, Sir,

Your obedient servant,

THOS. W. GIBSON,

Deputy Minister of Mines.

BUREAU OF MINES,

DEPARTMENT OF LANDS, FORESTS AND MINES,

Toronto, 1917.

STATISTICAL REVIEW

of the

MINERAL INDUSTRY OF ONTARIO FOR 1916

By THOS. W. GIBSON, Deputy Minister of Mines

The value of the mineral production of Ontario in 1916 was $65,303,822, an amount much in excess of that of any preceding year. The blow which the mining industry received from the outbreak of the great war in 1914 reduced the output of that year as compared with 1913 by 15 per cent., or nearly seven millions of dollars. More than the ground thus lost was regained in 1915, the production of which exceeded that of 1913 by over a million of dollars. The further advance made in 1916 was a notable one, the value of the output being greater than that of 1913 by upwards of twelve millions of dollars, or 22 per cent., and surpassing that of 1915 by over eleven millions of dollars, or 20 per cent.

The increase was almost wholly in metallic products, the production of the non-metallic substances remaining at about the same value as in 1915, namely, a little over ten millions of dollars. In part the enhanced value was due to higher prices, and in part to larger output. The metals of chief production in Ontario are nickel, copper, gold and silver. Following are figures which show the changes in output and value for 1916 of these metals as compared with 1915:

	Increase in production.	Increase in value.
Nickel, tons	7,260	$3,629,779
Copper, tons	2,822	1,377,451
Gold, ounces	86,242	1,837,868
Silver, ounces .... (decrease)	1,688,086	617,165

Advances in the prices of copper and silver were a marked feature of 1916, and the effect is very apparent in the statistics given above, especially in those pertaining to copper and silver. Further comment on prices and their effect upon production is reserved for later pages, under the heading of the respective metals.

Some fluctuations took place in the production of non-metallic substances in comparison with 1915. Brick, sewer pipe, drain tile and clay products generally declined, both in quantity and value; building materials other than brick, such as stone, lime, sand and gravel showed increases, but Portland cement fell off. Natural gas, which now competes with Portland cement for the leading place in the non-metallic list, and petroleum, were both lower in production than in 1915, but the petroleum product was worth more money. Graphite, quartz, mica and talc all increased. Gypsum declined. Fluorspar again appeared in the table of production. Iron pyrites, the mining of which is growing year by year, approached half a million dollars in value of output. Calcium carbide, whose production has largely increased by reason of the establishment at Welland of the Union Carbide

Company's plant, was dropped from the list of mineral products in 1915. The process of manufacture pertains more to the electro-chemical than to the mineral industry, and the limestone and coke, from which it is made, are of foreign origin, the former largely, and the latter wholly.

The aggregate value of the mineral production is reduced by excluding from the item of pig iron the quantity made from imported ore. Until 1915 the total output of the blast furnaces of the Province was given in the table, regardless of the origin of the ore. As the furnaces work for the most part on ore imported from the United States, it seemed advisable to confine the figures to the product of domestic ores.

The steady growth of the mineral industry of the Province is shown by comparing the value of the production say every fifth year since 1891, the date at which the Bureau of Mines was brought into existence. Following are the figures:—

Year.	Value Production. $	Growth per cent.
1891	4,705,673	
1896	5,235,003	11.2
1901	11,831,086	125.9
1906	22,388,383	89.2
1911	41,976,797	87.4
1916	65,303,822	55.5

Appended is Table I, which gives in summary form the leading statistics regarding the mineral production of 1916:—

TABLE I—MINERAL STATISTICS OF ONTARIO FOR 1916.

Product.		Quantity.	Value.	Employees.	Wages.
METALLIC.			$		$
Gold	ounces	497,833	10,339,259	2,600	3,067,225
Silver	"	20,007,367	12,703,591	2,650	2,538,420
Copper Ore	tons	1,052	33,102	90	25,948
Copper in matte (a)	"	22,430	8,332,153	4,821	4,920,720
Nickel in matte (a)	"	41,299	20,649,279		
Iron ore, exported	"	121,495	342,700	352	321,911
Pig Iron (b)	"	118,165	1,646,010	(b) 99	(b) 109,013
Cobalt (metallic)	lbs.	328,563	288,614	403	379,506
Cobalt oxide	"	691,681	473,713		
Nickel oxide	"	100,013	18,438		
Nickel (metallic)	"	42,411	17,847		
Other Nickel and Cobalt compounds	"	350,831	60,956		
Molybdenite (concentrates)	"	24,562	26,393	169	94,082
Lead	"	796,833	70,863	65	35,844
Metallic total			55,002,918	11,249	11,492,669

(a) Copper at 18½ and Nickel at 25 cents per pound in the matte.
(b) Production from Ontario Iron Ore only.

TABLE I—MINERAL STATISTICS OF ONTARIO FOR 1916. *Continued.*

Product.		Quantity.	Value.	Employees.	Wages.
NON METALLIC.			$		$
Arsenic, white, gray and other forms	lbs.	4,320,890	200,103	(c)	(c)
Asbestos	"	500	100	5	360
Brick, fancy, pressed and paving	M	31,742	318,942	341	209,253
Brick, common	"	60,441	509,559	1,329	170,044
Tile, drain	"	15,931	275,471		
" porous fireproofing	"	4,451	176,953	(d)	(d)
Cement, Portland	bbls.	2,143,949	2,242,433	659	428,774
Corundum	tons	67	8,763	39	10,046
Feldspar	"	12,965	42,159	119	33,063
Fluorspar	"	1,283	10,146	31	8,449
Graphite, refined	"	3,446	249,586	227	133,960
Gypsum, crushed, ground and calcined	"	36,668	116,206	99	61,718
Iron pyrites	"	175,593	471,807	117	111,368
Lime	bush.	1,453,254	265,356	242	140,202
Mica	tons	266	55,407	51	28,102
Natural gas	M. cu. ft.	17,953,396	2,404,499	653	404,039
Petroleum, crude	Imp. gals	6,890,681	387,846	(e) 105	(e) 83,012
Pottery			87,025	47	32,019
Quartz	tons	133,684	223,514	94	58,307
Salt	"	128,935	700,515	238	208,673
Sand and gravel	cu. yds.	1,265,973	470,963	344	212,123
Sewer pipe			216,749	169	111,644
Stone, building; trap, granite, etc.			755,313	736	396,812
Talc, crude and ground	tons	11,810	111,489	60	32,434
Total, non-metallic			10,300,904	5,705	3,174,402
Add metallic			55,002,918	11,249	11,492,669
Grand Total			65,303,822	16,954	14,667,071

(*c*) Included with Cobalt and Nickel compounds.
(*d*) Included with pressed, fancy and paving Brick.
(*e*) Employees and wages for proportion of domestic crude Petroleum distilled in Ontario refineries.

Table II presents the figures of production for the last five years. These enable the course of any particular branch of mining during that period to be followed. Notwithstanding the business depression and the beginning of the war which interrupted the progress of the industry in 1914, it will be seen that on the whole there has been a decided expansion, the annual value of the production having more than doubled during the time. Gold, nickel, copper and cobalt show the large increases consequent on the extensive developments which have been going on in the mining of these metals. Iron ore production is at best stationary. The decrease in pig iron, as compared with former years, is due to reporting only the product from domestic ore. The yield of silver, which attained its maximum in 1911, is falling, but the recent increase in price is sustaining the annual value. The growth of the figures representing the value of the cobalt and nickel by-products of the silver-cobalt ores reflects the steady development which has taken place in the treatment of these ores within the Province. The severe falling off in building materials, Portland cement, etc., is a natural result of the restriction, amounting almost to entire stoppage of construction work, since the outbreak of the war. The salt industry is now increasing its output, and the mining of quartz is also making considerable progress. Petroleum continues to decline slowly. Natural gas, for

the time being, appears to have reached its maximum, but new areas continue to be brought in. The rapid growth of iron pyrites mining is due in part to the war, and the scarcity of vessels for transporting copper pyrites and sulphur from Mediterranean ports. Difficulties in transportation have also had their effect in other branches of the industry.

TABLE II.—MINERAL PRODUCTION, 1912 TO 1916.

Product.	1912	1913	1914	1915	1916
METALLIC:	$	$	$	$	$
Gold	2,114,086	4,558,518	5,529,767	8,501,391	10,339,259
Silver	17,671,918	16,579,094	12,795,214	12,174,312	12,703,591
Cobalt	315,781	420,386	546,479	(a) 379,657	(a) 762,327
Copper	1,584,310	1,840,492	2,681,332	3,926,018	8,365,255
Nickel	4,736,460	5,250,803	5,136,804	(b) 17,042,230	(b) 20,685,564
Other Nickel and Cobalt compounds	....	....	45,189	9,227	60,956
Iron ore	93,558	138,750	169,427	171,345	342,700
Pig iron	8,054,369	8,719,892	7,041,079	1,891,400	1,646,010
Lead	1,290	....	....	....	70,863
Molybdenite	....	....	....	14,099	26,393
Platinum	80,736	....	....	....	....
Palladium	147,235	....	....	....	....
Metallic production	34,799,743	37,507,935	33,345,291	44,109,679	55,002,918
NON-METALLIC:					
Arsenic	79,297	64,146	116,624	148,379	200,103
Asbestos	....	....	....	....	100
Brick, common	3,178,250	3,452,352	2,336,207	763,591	509,559
" paving, fancy, etc.	221,986	243,119	237,440	158,515	318,942
" pressed	634,169	919,741	656,944	217,350	
Building and crushed stone	953,839	1,137,153	1,088,862	651,593	755,313
Calcium carbide	120,000	123,100	142,883	(c)	(c) ....
Cement, Portland	3,365,659	4,105,455	2,931,190	2,534,537	2,242,433
Corundum	233,212	137,036	65,730	31,398	8,763
Feldspar	28,916	67,142	55,686	47,031	42,159
Fluorspar	....	....	....	....	10,146
Graphite	65,076	93,054	87,167	115,274	249,586
Gypsum	50,246	92,627	221,175	(d) 190,422	116,206
Iron pyrites	71,043	171,687	264,722	353,498	471,807
Lime	381,672	390,600	333,407	244,953	265,356
Mica	57,384	55,264	40,402	33,490	55,407
Natural gas	2,268,022	2,362,021	2,346,687	2,622,838	2,404,499
Peat fuel	725	1,750	2,100	....	....
Petroleum (crude)	344,537	398,051	337,867	300,219	387,846
Phosphate of lime (apatite)	....	....	3,150	....	....
Pottery	52,445	52,875	25,720	49,387	87,025
Quartz	179,576	130,860	82,544	142,354	223,514
Salt	450,251	474,372	498,383	585,022	700,515
Sand and gravel	....	233,567	151,909	178,288	470,963
Sewer pipe	464,627	600,297	571,756	361,283	216,749
Talc	61,358	125,340	(e) 74,583	(e) 85,325	111,489
Tile, drain	279,579	292,767	277,530	321,253	275,471
" porous fireproofing	....	....	....	....	(f) 176,953
Non metallic production	13,541,869	15,724,376	12,950,668	10,136,000	10,300,904
Add metallic production	34,799,743	37,507,935	33,345,291	44,109,679	55,002,918
Total production	48,341,612	53,232,311	46,295,959	54,245,679	65,303,822

(a) Cobalt oxide and metallic Cobalt.
(b) Nickel in matte, oxide and metallic Nickel.
(c) Raw materials not all produced in Ontario.
(d) Crude Gypsum and Gypsum products.
(e) Crude and ground Talc.
(f) Included in former years with fancy, pressed and paving Brick.

Table III shows the total production of metals and metalliferous substances since mining began in Ontario. In the earlier stages of the industry and previous to the establishment of the Bureau of Mines, statistics of production were not officially or systematically collected, but the output was then insignificant as compared with the subsequent period, and the effect on the general result is correspondingly small.

TABLE III. TOTAL PRODUCTION OF METALS IN ONTARIO.

Metal.	Value to end of 1915.	Value, 1916.	Total Value.
	$	$	$
Gold	23,324,389	10,339,259	33,663,648
Silver	138,724,909	12,703,591	151,428,500
Platinum and Palladium	290,755	....	290,755
Cobalt (*a*)	2,418,663	762,327	3,180,990
Nickel (*b*)	68,442,600	20,685,564	89,128,164
Other Cobalt and Nickel Compounds	54,416	60,956	115,372
Copper	25,087,373	8,365,255	33,452,628
Iron Ore	7,851,181	342,700	8,193,881
Pig Iron	74,898,472	1,646,010	76,544,482
Lead	117,290	70,863	188,153
Zinc	92,410	....	92,410
Molybdenum	15,774	26,393	42,167
Total	341,318,232	55,002,918	396,321,150

(*a*) Includes metallic contents of Cobalt Oxide.
(*b*) " " " Nickel Oxide.

Legislation.—The Workmen's Compensation Act, which has been in operation since January 1, 1915, originally provided that mine operators should pay to the Board 3 per cent. of the wages-roll to provide funds for compensating employees for injuries sustained. The rate for miners was reduced to 2½ per cent. for the year 1916. The Act is achieving a useful purpose in obtaining speedy adjustment of compensation for injuries, and of ridding the courts of actions for damages, in many instances promoted by unscrupulous practitioners interested in obtaining costs for their services.

By an amendment to the Mining Act the Legislature, in April, 1916, provided that "every person who performs labour for wages in connection with any mine, mining claim, mining lands, or works connected therewith, shall be paid such wages at intervals of not more than two weeks." The semi-monthly pay day is now practically universal in the mines of the Province.

Dividends.—During the year 1916 the sum of $4,431,750 was distributed as dividends to the shareholders of gold mining companies, and $5,519,257.64 to the shareholders of silver mining companies, or $9,951,007.64 in all. From the beginning of the modern period of remunerative metal mining in Ontario, the dividends paid by gold companies have amounted to $9,786,625 and by silver companies $65,290,170.34, a total of $75,076,795.34. The gold mines at Porcupine were opened in 1910, and the silver mines of Cobalt in 1904. If to this sum were added the dividends paid out by the nickel-copper companies, the aggregate would be

greatly increased. There are few or no countries in the world where mining of gold, silver and nickel can be carried on under more favourable conditions than in Ontario.

A statement in detail of the dividends paid by gold and silver mining companies will be found on a later page.

Effects of the War

The effects of the war upon the mining industry of the Province have been of a varied character. Demand for metals and other substances required for munitions, accompanied by higher prices, greatly stimulated production of nickel, copper, iron, steel, lead and molybdenite. Indirect stimulus was given to the mining of iron pyrites through the difficulty of obtaining supplies of sulphur from other sources, owing, mainly, to the diminution of shipping. On the other hand, the scarcity of labour already existing was intensified, and higher wages became necessary. The cost of supplies, practically of all kinds, underwent an enormous increase; hence working expenses could not be kept from mounting.

Nickel and copper are prime necessaries of modern warfare, and consequently have been and remain in unprecedented demand. The price of copper rose to heights previously unknown to the present generation, and the production of both metals was correspondingly stimulated. The price of nickel was raised, but not in proportion to that of copper. Extraction of ore and output of bessemer matte at Sudbury reached the highest recorded figures.

Pig iron of a value of nearly ten millions of dollars was produced, which was not far short of double the value of the output of 1915, and the quantity of steel made was 45 per cent. in excess of that of the latter year. The total quantity of iron ore, domestic and imported, charged into the blast furnaces of the Province was greater than in any previous year.

Ontario has not as yet produced much lead, but the conditions in 1916 were favourable for working such deposits as she possesses, Canadian prices being nearly 50 per cent. higher than in 1915. The output, chiefly from a recently developed deposit, equipped with a smelter, at Galetta near Ottawa, much surpassed that of any other year.

Molybdenite continued in demand owing to its usefulness in making high speed tool steel, and to the action of the British government in requisitioning the supplies throughout the Empire at a fixed price. There was a considerable increase in the quantity of ore raised and concentrates produced, and there are now three plants for concentrating the ore, and two furnaces producing ferro-molybdenum in the Province. A. L. Parsons, in this volume, gives a description of the numerous molybdenite occurrences which have been opened in Ontario.

Iron pyrites is abundant, and was raised in much increased quantities last year. It is roasted for recovery of the sulphur required for making the sulphuric acid needed at the present time, among many other uses, in the manufacture of explosives. The residue after roasting is iron ore, and can be made use of in making pig iron.

Advances in Ore Treatment

The tendency in the mineral industry of Ontario, particularly in the metals, is towards the production of the finished article, as contrasted with the mere mining and selling of the raw ore or material.

In gold, the universal practice is to treat the ore and recover the metal on the spot. This is in part due to the fact that the gold ores of the world are in the main of low grade, and will not bear unnecessary handling or freight charges, also to gold milling being feasible in small as well as large plants, and in practically any locality.

At the outset of silver mining in the Cobalt district, and for several years afterwards, the custom was to ship the ores as they were extracted, and mainly to smelters in the United States. High grade material carrying thousands of ounces per ton could be sent anywhere, and the silicious nature of the lower grades made them desirable for mixing with more basic ores in the smelters of the western States. The first step towards greater manipulation in the Cobalt camp was the introduction of concentrators for the low grade ores, thus obviating the necessity of paying freight charges on worthless material. Refining works were established at Deloro, Thorold, Orillia and Welland, where cheap electrical power was available, and important industries were developed not only in the refining of silver, but in the manufacture of white arsenic, and of cobalt and nickel oxides. More recently still, further developments have been made by the conversion of part of the oxides produced into the metals themselves and into a variety of their salts, such as the carbonate, hydroxide and sulphate of cobalt, and the sulphate of nickel, also by the manufacture of stellite, which has come into considerable demand as a metal for high speed tools, and which is an alloy of cobalt, chromium and tungsten.

Concurrently with the growth of these industries outside of Cobalt, important developments have taken place in the camp itself. Bullion is now regularly produced both from high grade and low grade ores, and some remarkably ingenious and successful processes have been devised to meet the special problems presented by the Cobalt ores. More recently, flotation processes have occupied the stage, and are already largely employed. These processes will enable vast heaps of tailings to be profitably treated, and millions of ounces of silver recovered which would otherwise have been lost.

Not much has yet been actually accomplished in the treatment of copper ores. All the purely copper ore, for instance, raised last year was shipped to outside smelting plants, chiefly in British Columbia, except the ore at the Bruce Mines, which the Mond Nickel Company extracted and used as a flux in its converters at Coniston. A smelter was built near Thessalon some years ago, but never did much work, and a proposition has been mooted to convert an idle iron blast furnace at Midland into a smelter for copper. However, the nickel-copper refinery of the International Nickel Company now going up at Port Colborne will soon be turning out copper, either in the refined form or in the next stage to it.

The nickel industry, too, has undergone a considerable evolution since its establishment. At first low grade matte only was made, containing say 20 per cent. of nickel and copper. Subsequently, bessemer converters were employed, and the metallic contents of the matte increased to about 80 per cent. Small plants,

with additions built from time to time as necessities required, gave way to works of great size, equipped with all modern devices and machinery. In the Sudbury smelters, as in the silver mills at Cobalt, skilled metallurgists and engineers have installed special processes to meet special requirements. The late D. H. Browne applied the use of powdered coal to the reverberatory furnace, and took a step in advance which has been followed in the great copper smelters of the West. The substitution of the acid for the basic converter, the use of the sintering furnace for fines, the partial elimination of the open roast heap for green ore, and other improvements, testify to the desire of the nickel-copper companies to keep fully abreast or even in advance of the times. Mention has already been made of the refinery being built by the International Nickel Company, which is to have a capacity of 7,500 tons of refined nickel per annum that will probably be increased in the near future. And when the plans of the British America Nickel Corporation are fully carried into effect, there will be two nickel refineries in operation of capacity equal to the demand for the metal from the entire British Empire.

A company has also been formed for the manufacture of nickel-copper steel direct from the Sudbury ore, recent investigations and experiments having shown that the prejudice against the presence of a moderate proportion of copper in steel is not justified by the facts. The next logical step in the development of the nickel industry will be the establishment of plants for the making of nickel steel, either from imported or domestic iron ore if the latter can be had in sufficient quantity.

The beneficiation of low grade magnetic iron ore has been attempted by a variety of processes, and in three places at least with a considerable degree of success. At Trenton a concentration plant on the magnetic principle has treated a considerable quantity of ore from the Bessemer and Childs mines in Hastings county, and at Moose Mountain the leaner ores of that mine have been concentrated, also magnetically, and marketed in briquette form. The sideritic ores of the Magpie mine, and also some of the high sulphur material from the Helen mine, have been roasted and rendered amenable for use in the blast furnace. The Magpie ore after treatment carries about 2 per cent. of manganese and 53 per cent. of metallic iron, and is in good demand from United States furnaces. Ontario blast furnaces in 1916 made nearly 700,000 tons of pig iron, but, as formerly, much the smaller proportion of the iron ore charged into them came from the mines of the Province, the remainder being from the United States.

Molybdenite and lead have not figured very largely in Ontario so far. The making of war munitions, however, has for the time being stimulated the demand for both metals, and reference has already been made to the increased workings for them. Concentration plants for molybdenite have been followed by the installation of plants at Orillia and Belleville for the manufacture of ferro-molybdenum, the form in which it is used by steel makers. Formerly, the English supply of ferro-molybdenum came entirely from Germany. Another ferro compound, ferro-silicon, is being made on an extensive scale by Electro Metals, Limited, at Welland.

A smelter for the production of pig lead has been installed at Galetta on the Ottawa river, to treat the ore raised from the lead mine at that place. About 100 tons of lead were made last year.

Progress in Non-Metallic Industries

In the non-metallic branches of the industry, development towards the higher stages is not discernible to the same extent, and is perhaps not to be expected, since many of the products go into use practically in the form in which they are extracted. Some advances, however, are being made.

In the realm of clay goods, porous hollow tile, used chiefly for flooring and wall construction in steel-frame buildings, is increasing in importance, and Ontario clay workers are now making a high-class product.

Cement tile, brick and building blocks are also being more largely made than formerly. Salt, which until a short time ago, was used only as such, is now being subjected to electrolysis in the natural brine by the Canadian Salt Company for the production of caustic soda and bleaching powder.

Feldspar, for the most part, exported to be ground and used in the pottery and enamelled-ware trades of New Jersey and Ohio, has been employed in the manufacture of wall and floor tiles at Kingston. Attempts have been made to put the potash constituent of feldspar in soluble form and so make it available for fertilizing purposes, but so far the process has not been worked in a commercial way.

Iron pyrites has long been used in the manufacture of sulphuric acid at Sulphide, where the Nichols Chemical Company has a mine and plant.

The grinding and preparation of talc for a variety of uses is in successful operation at Madoc, also the milling and refining of graphite at the Black Donald mine near Calabogie, and by the Globe Graphite Company, Port Elmsley.

Quartz and quartzite are raised for use in the making of ferro-silicon, and in the conversion of low grade to Bessemer nickel-copper matte.

Importance of Hydraulic Power

In the absence of coal mines in this Province, and the scarcity and high cost of coal imported from the United States, it is highly important to the mineral industry that it can for the greater part employ electric power in its mines and plants. Hitherto, the requirements of the several mining districts of the north and northwest portions of the Province have been met by power developed from falls situated on near-by rivers. As the mines became more numerous and their power requirements greater, there have been times when the supply of power was not equal to the demand. Such a situation held back the development of the Kirkland Lake gold district, where relief has now been granted by the extension of the transmission lines from Cobalt. Even in Porcupine there is no plethora of developed power, and in the Sudbury area practically all of the important falls have been developed and are being made use of. For the uses of the British America Nickel Corporation, it is proposed to develop the Chaudiere falls on the French river near its exit from Lake Nipissing. The Canadian Copper Company has at present under way a scheme for procuring a greatly increased supply of power from the Spanish river, which will involve a considerable stretch of the river above High falls, the present source of supply, and the expenditure of a large sum of money. For refineries and the operation of chemical or manufacturing industries of a mineral type, the advantages of the neighbourhood of Niagara Falls are undoubtedly

great, as is proven by the very extensive growth of industries of this kind on both sides of the river. For plants of other kinds also, such as pulp and paper mills, abundance of hydraulic power is required in northern Ontario, and the control and regulation of the rivers of this region is a matter of much moment in the economic development of the Province. The mining industry is well served by the rivers of the north.

The water powers held under lease from the Crown produced a revenue of $27,225 for the fiscal year ending 31st October, 1916.

For details as to the various producing properties, metallic and non-metallic, and the field developments in progress, reference should be had to the reports of the Chief Inspector and assistant Inspectors of Mines, printed under the title "Mines of Ontario."

Gold

The world's gold production for 1916 is estimated as £95,725,000. This is a decrease of about £2,000,000 as compared with 1915, which was the highest on record. Two-thirds of the entire yield is produced in the British Empire. Africa yields 47 per cent. of the whole production, of which 11.25 per cent. comes from the great mines of the Rand.

The gold mines of the Province in 1916 yielded 497,833 fine ounces of gold, as against 411,588 ounces in 1915, an increase of 20 per cent. Most of the gold came from the mines of the Porcupine area, but there were contributors also from Kirkland lake, Munro township and Long lake. The schedule which follows gives the production of the several mines. A few ounces of gold were obtained from the non-nickeliferous copper ores shipped from the northwestern part of the Province to British Columbia, and from other casual sources.

Of the mines on the list the first seven are in the Porcupine camp. These produced a total of 452,995 ounces or 90 per cent. of the whole. The Tough-Oakes is at Kirkland Lake, where several other promising properties are preparing to enter the producing class. Croesus is in the township of Munro which, like Kirkland Lake, lies some distance east of Porcupine, between the line of the Timiskaming and Northern Ontario railway and the boundary of Quebec. The plant here was destroyed by fire in August, 1916, with disastrous loss of human life. Mining was not resumed until about the end of the year. The Long Lake mine, owned by the Canadian Exploration Company, Limited, is situated near Naughton station on the Sault branch of the Canadian Pacific railway. It is peculiar among the gold mines of the Province in being apparently isolated from other known auriferous deposits. The Long Lake mine closed down on the last day of July, and only diamond drilling has been carried on since. The area in this neighbourhood was examined during the year on behalf of the Bureau of Mines by Prof. M. B. Baker, of Queen's University, Kingston, whose report will be found in another part of this volume.

The production of the various gold mines, the tonnage of ore treated and other particulars, are shown in the following table:

TABLE IV. GOLD MINING IN 1916.

Mine	Tons Ore milled	Gold Produced		Silver Produced		Total Value	Extraction per ton	[illegible]
		Fine ounces	Value	Fine ounces	Value			
			$ c.		$ c.	$ c.	$ c.	$
1. Hollinger.......	601,854	244,120.8	5,046,651 75	41,236.8	26,749 30	5,073,401 05	8 43	[illegible]
2. Dome............	444,900	103,808.8	2,142,938 81	17,089.4	10,880 98	2,153,819 79	4 84	[illegible]
3. McIntyre(a).....	136,489	55,755.5	1,209,275 97	12,000.1	8,797 13	1,218,073 10	8 85	...
4. Porc. Crown.....	54,273	27,856.6	575,725 05	3,926.8	2,596 84	578,321 89	11 27	249
5. Schumacher......	46,463	10,841.3	224,157 26	1,700.8	1,143 96	225,301 22	4 84	...
6. Porc. Vipond....	43,041	8,508.7	175,874 11	1,255.0	812 08	176,686 52	4 10	......
7. Dome Lake.......	6,542	871.4	16,785 33	45.?	29 34	16,814 77	2 57	......
8. Tough-Oakes.....	39,865	33,991.3	702,760 70	13,051.?	8,864 76	711,625 46	17 85	265...
9. Long Lake.......	26,846	9,229.8	187,002 62	152.5	99 61	187,102 23	6 99	......
10. Croesus(b).....	177	2,495.1	51,578 34	206.1	144 18	51,722 52	......	......
11. Miscellaneous(c)	......	314.5	6,504 08	......	......	6,504 08	......	......
Total..........	1,397,750	[illegible]	10,339,259 15	[illegible]	60,118 18	[illegible]	(d) [illegible]	[illegible]

(a) Includes McIntyre-Jupiter and McIntyre Extension.
(b) Tons raised.
(c) Small producers, slag, copper, ores, etc.
(d) Average of mines, 1 to 9 inclusive.

The gold production of the Province and of the Porcupine area respectively, for the last seven years, are shown by the figures appended. It will be seen that the Porcupine mines have supplied very much the larger share.

Year.	Total Production. $	Porcupine. $	Percentage from Porcupine.
1910....................	68,498	35,539	51.8
1911....................	42,637	15,437	36.2
1912....................	2,114,086	1,730,628	81.8
1913....................	4,558,518	4,294,113	94.1
1914....................	5,529,767	5,190,794	93.8
1915....................	8,501,391	7,536,275	88.6
1916....................	10,339,259	9,397,536	90.8

The development of the Porcupine gold camp has been very satisfactory, and the characteristics of the deposits there are such as to warrant the expectation that the mines will have a reasonably long life. But it is not risking much to say that other gold areas in northern Ontario which are now in the development stage will ere long be contributing their quota of bullion. Already one field, that at Kirkland lake, where the Tough-Oakes mine is situated, is making a substantial production, and several new properties there now in various stages of development, are likely to add to the total. Additional areas, such as Boston Creek, West Shining Tree, Kowkash and Dryden, are passing through the earlier stages in the evolution of a new gold camp. The old St. Anthony mine at Sturgeon lake has become the property of New York investors, who are opening it up and who appear to be satisfied that it will prove a profitable, though perhaps not a large, mine. There are prospects in the Seine river, Lake of the Woods, Larder lake and eastern Ontario areas, which are by no means destitute of merit, and it may yet prove that some of these old fields, though for the present idle, will come again into action.

The latest gold finds are in the township of Powell and Cairo, in the Montreal river Mining Division. At Bourke's siding in the township of Maisonville, also, good samples of gold ore have been found, but so far there has been little work done.

It is one of the aims of the Bureau of Mines to obtain and publish, in the early stages of their development, reliable data regarding the geology and mineralogy of newly located mineral areas. In pursuance of this policy, Ellis Thomson was commissioned last year to make a preliminary examination of the Dryden gold area, and P. E. Hopkins continued his work in the Kowkash-Tashota field on the National Transcontinental railway northeast of Lake Nipigon. A. G. Burrows also made a general reconnaissance along the line of the Canadian Northern railway eastward of Lake Nipigon. The reports of these gentlemen are printed in this volume, and are accompanied by geological maps of the respective areas.

Experience shows that very practical assistance can be given the prospector by furnishing him with a map of a newly found mineral belt, and providing him with a key to the geological significance of its rock formations. A map of this kind with marginal annotations is more convenient of reference, more easily carried in the field than a printed volume, and serves almost every purpose of the latter.

Following is a list of the productive gold mines last year:—

PRODUCING GOLD MINES, 1916.

Name of Company.	Name of Mine.	Locality.	P.O. Address of Manager, etc.
Canadian Exploration Company, Limited	Long Lake	Long Lake	Naughton.
Croesus Gold Mines, Limited	Croesus	Munro township.	Matheson.
Dome Mines, Limited	Dome	Porcupine	South Porcupine.
Dome Lake Mining and Milling Company, Limited	Dome Lake	Porcupine	South Porcupine.
Hollinger Consolidated Gold Mines, Limited	Hollinger	Porcupine	Timmins.
McIntyre-Porcupine Mines, Limited.	McIntyre	Porcupine	Schumacher.
Porcupine Crown Mines, Limited	Porcupine Crown	Porcupine	Timmins.
Porcupine Vipond Mines, Limited	Vipond	Porcupine	Timmins.
Schumacher Gold Mines, Limited	Schumacher	Porcupine	Schumacher.
Tough-Oakes Gold Mines, Limited.	Tough-Oakes	Kirkland Lake.	Kirkland Lake.

Silver

The silver mines of the Province produced and shipped 20,007,367 fine ounces of silver, compared with 21,823,660 ounces in 1915. There was thus a considerable falling off in quantity, amounting to 24 per cent. On the other hand, the money value of the output was greater than in 1915, being $12,703,591 as against $12,174,312, an increase of 4.3 per cent. The better prices prevailing for silver last year influenced the companies to maintain a high standard of production, notwithstanding the difficulties created by the labour shortage and the increased cost of supplies. The average price for fine silver in New York was 65.661 cents per ounce, as compared with 49.69 cents in 1915. The lowest figure was 55.875 cents, and the highest 77.25 cents. The large demand for silver is in part due to the requirements of the belligerent countries, where silver is being coined to replaee gold withdrawn from circulation.

According to camps, the output was as follows:—

	Ounces.
Casey township	115,900
South Lorrain	77,280
Gowganda	383,393
Cobalt proper	19,008,517
Silver recovered from gold, copper and lead ores	92,277
Total	20,007,367

The mines sending out more than one million ounces of silver were:

	Ounces.
Nipissing	3,819,768
Townsite-City	3,115,637
Kerr Lake	2,527,062
Coniagas	1,816,287
McKinley-Darragh-Savage	1,055,959

Those shipping less than a million ounces, but more than half a million were:

Cobalt Lake	994,608
Temiskaming	873,507
La Rose Consolidated	830,707
O'Brien	770,068
Seneca-Superior	675,302
Beaver Consolidated	567,993
Penn-Canadian	518,585

Table VI gives the total production of silver from the Cobalt mines since they were opened in 1904, classifying the shipments as ore, concentrates and bullion. It must be understood that the table deals with shipments as they leave Cobalt camp for outside points, whether in Ontario or the United States, and not with inter-camp movements of ore, as for instance from a mine to a concentration or refining plant in Cobalt itself. A very large part of the shipments from Cobalt goes to the refining plants in older Ontario, where the silver is recovered as merchantable bars, and the other constituents of the ore obtained as metallic cobalt and nickel, refined oxides and alloys or other products of cobalt and nickel. The arsenic is produced as white arsenic, and now also in the metallic form.

The table is as follows:—

TABLE V—SILVER PRODUCTION, COBALT MINES, 1904 TO 1916.

Year.	No. of Producing Mines.	Shipments and Silver Contents							Total.	
		Ore.		Av. per ton.	Concentrates.		Av. per ton.	Bullion.	Ounces.	Value
		Tons.	Oz.	Oz.	Tons.	Oz.	Oz.	Oz.		$
1904....	4	158	206,875	1,309	....	....	....	....	206,875	111,887
1905....	16	2,144	2,451,356	1,143	....	....	....	....	2,451,356	1,360,503
1906....	17	5,335	5,401,766	1,013	....	....	....	....	5,401,766	3,667,551
1907....	28	14,788	10,023,311	677	....	....	....	....	10,023,311	6,155 391
1908....	30	24 487	18,022,480	736	1,137	1,415,395	1,244	....	19 437,875	9,133,378
1909....	31	27,729	22,436,355	809	2,948	3,461,470	1,174	....	25,897 825	12,461,576
1910....	41	27,437	22,581,714	821	6,845	7,082,834	1,030	980,633	30,645,181	15,478,047
1911....	34	17,278	20,318,626	1,176	9,375	8,056,189	858	3,132,976	31,507,791	15,953,847
1912....	30	10 719	15,395,504	1,436	11,214	9,768,228	871	5,080,127	30,243,859	17,408,935
1913....	35	9,861	13,668,079	1,386	11,016	8,489,321	770	7 524,575	29,681,975	16,553,981
1914....	32	4,302	6,504,753	1,511	12,152	8,915,958	733	9,742,130	25,162,841	12,765,461
1915....	24	2,865	6,758,286	2,359	11,996	10,001,548	834	7 986,700	24,746,534	12,135,816
1916....	28	2,177	4 672,500	2,146	8,561	7,598,011	887	7,644,579	19,915,090	12,643,175
Total ..	....	149,280	148,441,605	994	75,244	64,788,954	861	42,091,720	255,322,279	135,829,548

The average annual production of silver from the mines of Cobalt until the end of 1916 was 19,640,292 ounces, very nearly the output for last year. A glance at the table will show that the production grew very rapidly in the earlier years of the camp, reaching the maximum in 1911. Since then there has been a decrease year by year, but the falling-off has been at a slower rate than was the rise. So far, the curve depicting the decline in the yield of Cobalt has been much flatter than that representing the increase.

Shipments of ore and concentrates from Cobalt to refineries in the United States comprised 364 tons of ore carrying 408,014 ounces, and 3,700.35 tons of concentrates carrying 1,629,841 ounces—a total of 2,037,855 ounces of silver.

The Flotation Process

Doubtless the process of flotation for the concentration of low grade ores is one of the most important developments of modern metallurgy. It has been found adapted to the treatment of the heaps of tailings which have accumulated round the mines of Cobalt, as well as to the leaner wall and mine rock, and its effect in prolonging the life of the silver mining industry there will undoubtedly be considerable. Material incapable of being treated by ordinary gravity methods is susceptible to the flotation process, and what was formerly waste is now a source of profit. There is a description of the flotation process as applied to the Cobalt ores in that part of this Report dealing with the Mines of Ontario.

The bitterly contested ligitation regarding the respective rights of rival patentees and claimants has for some time deprived the mining industry of the full use of this remarkable invention, and the probability is now that these rights are largely settled, the successful contestants will try to recoup themselves for their expenses by charging roundly for the privilege of using the process.

The introduction of flotation has led to a demand for oil of a quality required in the process. Experience has shown that to produce the necessary froth, a proportion of pine oil is desirable, if not indispensable. This has so far come from the southern States, but the demand has brought about an increase of price, and also, it is said, a deterioration of quality. Successful efforts have been made to obtain this oil from Canadian woods, stumps of the red pine, which abound in the forests of the north where lumbering operations have been carried on, having been found to yield oil well suited for the purpose. More recently it has been shown that an oil obtained from the distillation of hardwood in charcoal plants, heretofore of little value, is well suited for flotation processes.

Extraction by flotation is subject to peculiar fluctuations in its results, from causes which are not as yet thoroughly understood. As experience with the process accumulates, its operation will tend to become standardized. At the McKinley-Darragh-Savage mine, slimes finer than 200-mesh were treated by flotation, the average contents of the "heads" for seven months being 6.78 ounces per ton. A saving of 71.37 per cent. of the silver was made, the "tails" carrying an average of 1.909 ounces per ton. The average contents of the concentrates produced was 262 ounces of silver per ton. The chief economic minerals recovered were argentite, proustite, pyrargyrite and metallic silver.*

*Report by Arthur A. Cole on the Mining Industry in that part of Northern Ontario served by the T. & N. O. railway, 1916, p. 22.

Refining of ore and concentrates produced at Cobalt was carried on throughout the year by the following companies, namely, Coniagas Reduction Company, Limited, at Thorold, Deloro Smelting and Refining Company, at Deloro, and Metals Chemical, Limited, at Welland. The plants of the first two companies are operated largely on high grade ore and concentrates, and while recovery of silver is the primary purpose, they also obtain the arsenic, cobalt and nickel constituents which the raw materials contain. These are produced in commercial form as white arsenic and cobalt and nickel oxides. Both now refine the oxides to obtain metallic cobalt; at Deloro metallic nickel and also the alloy stellite are produced; and at Thorold metallic arsenic. At the works of Metals Chemical, Limited, are treated only low grade ores and residues from the silver mills at Cobalt, consequently the silver output of this company is negligible. Crude arsenic only is obtained, but a considerable range of cobalt and nickel compounds is produced. These comprise the refined oxides of both metals, carbonate and sulphate of cobalt, and sulphate of nickel. In the manufacturing process, the oxides are first obtained, which serve as the raw materials for the subsequent forms. Nickel sulphate is coming extensively into use in the hydrogenization of liquid oils or fats, especially in the manufacture of soap.

The figures given below show that over a million dollars' worth of products were obtained at the refineries from the material treated, or an average of $136 per ton, altogether exclusive of the silver product, which had a value of $722 per ton.

The table is significant of the development which has taken place in the home metallurgy of the silver-cobalt ores since the mines of Cobalt were opened. Adding the bullion produced at these refineries to that obtained at the mills in Cobalt itself, it will be seen that out of a total of 19,915,090 ounces of silver contained in the ores raised at Cobalt in 1916, no less than 17,310,095 ounces were refined in Ontario, or 87 per cent. of the entire production.

Following is the table:—

OPERATION OF ONTARIO SILVER COBALT REFINERIES, 1916.

Product.		Quantity.	Value.
Ore, Concentrates and Residues treated	tons	7,771	....
Silver recovered	fine ounces	9,665,516	5,618,237
Arsenic, White, shipments	lbs.	4,058,822	186,509
Arsenic, Crude, shipments	"	179,955	5,387
Arsenic, Metallic, shipments	"	82,703	8,207
Cobalt Oxides, shipments	"	691,681	473,713
Cobalt Carbonate and Sulphate, shipments	"	60,943	19,115
Cobalt, Metallic, shipments	"	328,563	288,614
Nickel Oxide, shipments	"	100,013	18,438
Nickel Sulphate, shipments	"	232,450	18,868
Nickel, Metallic, shipments	"	42,411	17,847
Cobalt and Nickel Oxides, not separated, shipments	"	57,437	22,973
Total value of products			$6,677,908

The average number of workmen employed throughout the year was 103, and there was paid to them as wages the sum of $379,506.

TABLE VI. DIVIDENDS AND BONUSES BY GOLD AND SILVER MINING COMPANIES TO DECEMBER 31ST, 1916.

Name of Company.	Date of Incorporation.	Authorized Capital.	Capital Stock Issued.	Par value per share.	Amount of Dividends and Bonuses declared to end of 1915	Amount of Dividends and Bonuses declared during 1916.		Total of Dividends and Bonuses declared to Dec. 31st, 1916.	Last Dividend or Bonus. Date declared.
GOLD COMPANIES.		$	$	$ c.	$	$ c.	%	$	
Dome Mines Company, Ltd.	Mar. 23, 1910	5,000,000	4,000,000	10 00	400,000 00	800,000 00	20	1,200,000 00	Dec. 1, 1916
Hollinger Consolidated Gold Mines, Ltd.	May 20, 1916	25,000,000	24,600,000	5 00	4,170,000 00 / **160,000 00	3,126,000 00	13	7,456,000 00	Dec. 31, 1916
Porcupine Crown Mines, Ltd.	May 26, 1913	2,000,000	2,000,000	1 00	480,000 00	240,000 00	12	720,000 00	Oct. 1, 1916
Rea Consolidated Gold Mines	April 5, 1911	1,000,000	200,000	5 00	12,000 00	....	....	12,000 00	....
Tough Oakes Gold Mines, Ltd.	July 15, 1913	3,000,000	2,657,500	5 00	132,875 00	265,750 00	10	398,625 00	Dec. 27, 1916
Total from Gold Companies					5,354,875 00	4,431,750 00		9,786,625 00	
SILVER COMPANIES.									
Beaver Consolidated Mines, Ltd.	Mar. 1, 1907	2,000,000	2,000,000	1 00	590,000 00	60,000 00	3	650,000 00	April 8, 1916
Buffalo Mines, Ltd., The	April 27, 1906	1,000,000	1,000,000	1 00	2,787,000 00	....	....	2,787,000 00	May 28, 1914
Casey Cobalt Silver Mining Company, Ltd.	Dec. 19, 1906	100,000	100,000	1 00	203,249 33	....	....	203,249 33	April 22, 1914
Cobalt Comet Mines, Ltd.	April 16, 1913	1,000,000	1,000,000	1 00	230,000 00	....	....	230,000 00	April 1, 1915
Coniagas Mines, Limited, The	Nov. 24, 1906	4,000,000	4,000,000	5 00	7,840,000 00	600,000 00	15	8,440,000 00	Nov. 1, 1916
Crown Reserve Mining Co., Ltd.	Jan. 16, 1907	2,000,000	1,999,957	1 00	6,102,408 30	88,440 70	5	6,190,849 00	Dec. 28, 1916
Kerr Lake Mining Company, Ltd.	Aug. 9, 1905	40,000	40,000	100 00	6,508,000 00	629,000 00	....	7,128,000 00	Oct. 10, 1916
La Rose Mines, Ltd.	May 31, 1908	6,000,000	6,000,000	5 00	5,702,546 84	328,000 00	4	6,030,546 84	Dec. 15, 1916
McKinley-Darragh-Savage Mines of Cobalt Ltd.	April 17, 1906	2,500,000	2,247,692	1 00	4,674,207 42	269,723 04	12	4,943,930 46	Nov. 22, 1916
†Mining Corporation of Canada, Ltd.	Mar. 20, 1914	2,075,000	2,075,000	1 00	778,125 00	583,593 75	....	1,361,718 75	Sept. 30, 1916
Nipissing Mining Company, Ltd.	Dec. 16, 1904	250,000	250,000	100 00	14,453,297 25	1,835,000 00	....	16,288,297 25	Dec. 18, 1916
Penn-Canadian Mines, Ltd.	April 24, 1912	1,500,000	1,349,705	1 00	....	67,485 25	5	67,485 25	Nov. 10, 1916
Seneca-Superior Silver Mines, Ltd.	Sept. 29, 1911	500,000	478,884	1 00	981,212 20	598,605 00	....	1,579,817 20	Dec. 15, 1916
Temiskaming Mining Co., Ltd.	Nov. 5, 1906	2,500,000	2,500,000	1 00	1,459,156 25	225,000 00	9	1,684,156 25	Nov. 22, 1916
Wettlaufer Lorrain Silver Mines, Ltd.	Nov. 30, 1908	1,500,000	1,416,590	1 00	637,465 50	....	....	637,465 50	Sept. 22, 1913
Trethewey Silver Cobalt Mines, Ltd.	May 30, 1906 / June 1, 1911	2,000,000	1,000,000	1 00	1,061,998 50	50,000 00	5	1,111,998 50	Dec. 1, 1916
Right of Way Mines, Ltd.	Sept. 11, 1909	2,000,000	1,685,500	1 00	219,115 20	25,282 50	1½	244,397 70	Sept. 15, 1916

Right of Way Mining Co., Ltd.	July 13, 1906	500,000	500,000	1 00	324,643 93	....	324,643 93	....
Peterson Lake Silver-Cobalt Mining Co., Ltd.	April 11, 1906	3,000,000	2,401,820	1 00	294,222 95	168,127 40	462,350 35	....
‡City of Cobalt Mining Co., Ltd.	Oct. 5, 1906 / Jan. 7, 1909	500,000 / 1,500,000	1,500,000	1 00	145,000 00	....	145,000 00	April 15, 1909
Cobalt Central Mines Co., Ltd.	Dec. 13, 1906	5,000,000	5,000,000	1 00	192,845 00	....	192,845 00	Aug. 25, 1909
‡Cobalt Lake Mining Co., Ltd.	Dec. 22, 1906	3,000,000	3,000,000	1 00	465,000 00	....	465,000 00	May 29, 1914
Cobalt Silver Queen, Ltd.	April 1, 1906	1,500,000	1,500,000	1 00	315,000 00	....	315,000 00	Dec. 31, 1908
‡Cobalt Townsite Mining Co., Ltd.	May 8, 1906	100,000	45,011	1 00	1,042,259 61	....	1,042,259 61	Nov. 11, 1914
Foster Cobalt Mining Co., Ltd.	Feb. 14, 1906	1,000,000	915,588	1 00	45,000 00	....	45,000 00	Jan. 1, 1907
Temiskaming and Hudson Bay Mining Co. Ltd.	July 29, 1903	25,000	7,761	1 00	1,940,250 00	....	1,940,250 00	Nov. 10, 1914
Hudson Bay Mines, Ltd.	July 16, 1909	3,500,000	3,200,050	5 00	778,909 42	....	778,909 42	Aug. 31, 1913
Total from Silver Companies					59,770,912 70	5,519,257 64	65,290,170 34	
Total dividends					65,125,787 70	9,951,007 64	75,076,795 34	

Hollinger Consolidated Gold Mines Limited is a consolidation of the Acme Gold Mines Limited, Millerton Gold Mines Limited, and Hollinger Gold Mines Limited. The properties of the several companies were contiguous, and were largely owned by the same group of persons. All are now being operated through one central shaft, and all ore is treated in the one mill. The accounting of the Consolidated Company dates from January 1st, 1916.

Acme Gold Mines, Limited.

† Mining Corporation of Canada, Limited, owns and operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines. During the year its registry was changed from England to Ontario.

‡ Now owned and operated by Mining Corporation of Canada, Limited.

Refining Bounties

The Metal Refining Bounty Act (R.S.O. 1914, chapter 33) provides a bounty of six cents per pound on the nickel and cobalt produced in Ontario in the metallic form or as the refined oxides, the bounty being based on the metallic contents. The figures given below show the bounties paid for the production of 1916. The Act limits the amount payable as cobalt bounty in any one year to $30,000, so that if a larger quantity is produced than can be paid for at six cents per pound out of the maximum amount, the bounty is subject to a pro rata reduction. This happened in 1916, the excess in production bringing the rate per pound of metallic cobalt contents down to 3.9131 cents. The Act expired 10th April, 1917, and was not re-enacted. Its object, which was to encourage the refining of the complex ores of the Cobalt area within the Province, has been fully attained. The complete treatment of these ores includes the recovery not only of the silver, which is the element of chief value, but also the cobalt, nickel and arsenic which they contain. Five plants have been built since the Act was passed, at Copper Cliff, Orillia, Thorold, Deloro and Welland, respectively. The first has gone out of commission and has been dismantled; the second was burned, while the last three remain actively at work. Nearly 50 per cent. of the silver mined in Ontario is refined at Deloro and Thorold, and large quantities of cobalt and nickel in various forms are produced at these and the Welland plants. In the cobalt oxide trade the Ontario refineries in fact control the output for the world, for competition from other sources of cobalt has been reduced to a minimum since the opening of the Cobalt mines and the establishment of the refining industry here.

The Bounty Act also provided bounties on refined copper, also on arsenic made from mispickel, deposits of which are found in Hastings County and elsewhere, but no copper or arsenic bounties have ever been claimed or earned.

The quantities of cobalt and nickel products made by the several refineries in 1916 and the bounty paid are set out in the following table:—

PAYMENTS UNDER METAL REFINING BOUNTY ACT

Company.	lbs. Product.	lbs. Metallic Cobalt contained.	lbs. Metallic Nickel contained.	Bounty Cobalt	Bounty Nickel	Total Bounty.
Canadian Smelting & Refining Co., Ltd.				$ c.	$ c.	$ c.
Cobalt Oxide	36,137	26,221	....	1,026 05		
Nickel Oxide	16,156	....	11,364	....	681 84	1,707 89
Metals Chemical, Ltd.						
Cobalt Oxide	114,419	81,192				
Cobalt Carbonate	5,723	2,722				
Cobalt Hydroxide	5,966	3,400				
Cobalt Sulphate	54,088	10,942				
	Total..	98,256	....	3,844 85		
Nickel Oxide	31,364	....	20,104			
Nickel Sulphate	212,709	....	44,030			
		Total..	64,134	....	3,848 04	7,692 89
Deloro Smelting & Refining Co., Ltd.						
Cobalt Oxide	91,548	55,844				
Cobalt Oxide	103,246	65,912				
Cobalt Metal	64,650	60,331				
Cobalt Metal	85,693	80,362				
Cobalt Fines	14,288	13,322				
Cobalt Fines	5,250	4,674				
Stellite	57,792	31,785				
		312,230				
	Less ..	567				
	Total..	311,663	....	12,195 68		
Nickel Oxide	2,838	....	2,050			
Nickel Oxide	1,600	....	1,176			
Nickel Metal	13,305	....	12,437			
Nickel Metal	28,478	....	28,161			
			43,824			
		Less...	10,721			
	Total..	....	33,103	....	1,986 18	14,181 86
Coniagas Reduction Co., Ltd.						
Cobalt Oxide	338,168	239,186				
Cobalt Metal	94,190	91,326				
	Total..	330,512	....	12,933 26		
Nickel Oxide	48,478	....	34,041	....	2,042 46	14,975 72
Total	....	....	....	29,999 84	8,558 52	38,558 36

In the table below is given the annual and total production of the chief elements of value, from the mines of Cobalt since they were opened in 1904. As regards the subsidiary elements, nickel, cobalt and arsenic, the table until 1913 proceeds upon the assumption that the ores and concentrates produced at Cobalt contained on the average 1.47 per cent of nickel, 3.20 per cent. of cobalt, and 14.28 per cent. of arsenic. Since that time the figures represent, in the case of nickel and cobalt, the metallic contents of the oxides and other substances produced in the refineries of Ontario, and in the case of arsenic, the recoveries of white, crude and metallic arsenic in the same plants. The latter method necessarily loses sight of so much of these constituents as are contained in the ores and concentrates exported to the United States since it is not customary to assay such consignments for them: but the exports of raw ore and concentrates are yearly becoming less, and now amount, on the basis of the silver contained, to not more than 13 per cent. of the production.

The ores occasionally carry a little copper, as at the Timiskaming mine, where small quantities have been recovered: also bismuth and mercury. The proportion of bismuth is too small to warrant efforts to save it, but the mercury is said to be present in sufficient proportion to prevent losses of that metal when used for amalgamation in the Nipissing process of treating the high-grade ore.

TABLE VII.—TOTAL PRODUCTION, COBALT SILVER MINES, 1904 TO 1916.

Year.	Nickel.		Cobalt.		Arsenic.		Silver.		Total Value.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Ounces.	Value.	
		$		$		$		$	$
1904....	14	3,467	16	19,960	72	903	206,875	111,887	136,217
1905....	75	10,000	118	100,000	549	2,693	2,451,356	1,360,503	1,473,196
1906....	160	....	321	80,704	1,440	15,858	5,401,766	3,667,551	3,764,113
1907....	370	1,174	739	104,426	2,958	40,104	10,023,311	6,155,391	6,301,095
1908....	612	....	1,224	111,118	3,672	40,373	19,437,875	9,133,378	9,284,869
1909....	766	....	1,533	94,965	4,294	61,039	25,897,825	12,461,576	12,617,580
1910....	504	....	1,098	54,699	4,897	70,709	30,645,181	15,478,047	15,603,455
1911....	392	....	852	170,890	3,806	74,609	31,507,791	15,953,847	16,199,346
1912....	429	14,220	934	314,381	4,166	80,546	30,243,859	17,408,935	17,818,082
1913....	377	13,326	821	420,386	3,663	64,146	29,681,975	16,553,981	17,051,839
1914....	(*a*) 90	28,978	(*a*) 351	590,406	2,030	116,624	25,162,841	12,765,461	13,501,469
1915....	(*b*) 35	28,353	(*b*) 206	383,261	2,490	148,379	24,746,534	12,135,816	12,695,809
1916....	(*b*) 79	59,380	400	805,014	2,160	200,103	19,915,090	12,643,175	13,707,672
Total.	3,903	158,898	8,613	3,250,210	36,197	916,086	255,322,279	135,829,548	140,154,742

(*a*) Metallic contents of Nickel and Cobalt oxides respectively.
(*b*) Metals and metallic contents of all Nickel and Cobalt compounds.

Following is a list of the productive silver mines in operation at Cobalt in 1916:—

PRODUCING SILVER MINES IN 1916.

Company or Owner.	Mine.	P.O. Address of Manager, etc.
Aladdin Cobalt Company, Limited	Chambers Ferland	Cobalt.
Beaver Consolidated Mines, Limited	Beaver	Cobalt.
Bellellen Syndicate	Bellellen	Silver Centre.
Buffalo Mines, Limited, The	Buffalo	Cobalt.
Casey Cobalt Silver Mining Company, Limited	Casey Cobalt	New Liskeard.
Christopherson, S., and associates	Reeve Dobie	Gowganda.
Cobalt Comet Mines, Limited	Drummond	Giroux Lake.
Coniagas Mines, Limited	Coniagas	Cobalt.
Crown Reserve Mining Company, Limited	Crown Reserve	Cobalt.
Glen Lake Cobalt Mines, Limited	Foster	Giroux Lake.
Hargrave Silver Mine, Limited	Hargrave	Cobalt.
Hudson Bay Mining Company, Limited	Hudson Bay	Cobalt.
Kerr Lake Mining Company, Limited	Kerr Lake	Cobalt.
La Rose Mines, Limited	La Rose	Cobalt.
McKinley-Darragh-Savage Mines of Cobalt, Limited	McKinley Darragh Savage	Cobalt.
Mercer Silver Mines, Limited	Cart Lake	Cobalt.
Mining Corporation of Canada, Limited, The	Cobalt Lake, Townsite City	Cobalt.
Nipissing Mining Company, Limited	Nipissing	Cobalt.
O'Brien, M. J.	O'Brien	Cobalt.
O'Brien, M. J.	Miller-Lake O'Brien	Gowganda.
Penn-Canadian Mines, Limited	Penn Canadian	Cobalt.
Pittsburg Lorrain Syndicate	H.R. 105, or Currie	Silver Centre.
Right of Way Mines, Limited	Right of Way	Cobalt.
Seneca-Superior Silver Mines, Limited	Seneca Superior	Cobalt.
Temiskaming Mining Company, Limited	Temiskaming	Cobalt
Trethewey Silver Cobalt Mine, Limited	Trethewey	Cobalt.
Wettlaufer-Lorrain Silver Mines, Limited	Wettlaufer	Silver Centre.

Copper

The nickel-copper mines of the Sudbury district remain the principal source of the copper of Ontario, and the larger scale upon which the mines were worked during 1916 naturally increased the output of this metal. Bessemer matte produced by the Sudbury smelters to the extent of 80,010 tons contained 22,430 tons of copper, an average of 28 per cent. The production in 1915 was 19,608 tons, the increase for 1916 being at the rate of 14 per cent. At an average valuation of 18.5 cents per pound for the copper in the matte, the quantity produced in 1916 was worth \$8,299,051. As in past years, the matte was exported by the two producing companies, the Canadian Copper Company and the Mond Nickel Company, Limited, to New Jersey and Wales, respectively, for refinement. At the works of the former, the copper is recovered in part as blister copper and in part as electrolytic copper; at those of the latter, it is obtained in the form of copper sulphate. The chief market for the last-named product is in the vineyards of the Mediterranean countries as a fungicide. Copper sulphate is also used in Canada and elsewhere along with lime in Bordeaux mixture to check potato blight.

The average monthly price of electrolytic copper in New York for 1916 was 27.202 cents per pound, the highest figure for over 40 years. The demand arising out of the war caused this advance, and a natural result of the high prices was the opening of mines and deposits which, under normal conditions, are unprofitable to work. Copper ore was raised at the Tip-Top mine, west of Port Arthur, and from a newly discovered deposit near Mine Centre. Shipments from both sources were made to the smelter at Trail, B.C. Small quantities also were obtained by developing prospects along the line of the Timiskaming and Northern Ontario railway, and on the north shore of Lake Huron. The Massey mine and a property in the township of Gould, both in the last-named district, produced and shipped a quantity of ore. The product of the old Bruce mines, now owned and worked by the Mond Nickel Company, went to the smelter at Coniston, and is accounted for in the mattes there produced. Some 1,052 tons of copper ore was obtained from the above sources, valued at $33,402.

The non-nickeliferous mines and prospects producing ore in 1916 were as follows:—

COPPER PRODUCERS IN 1916

Name of Operator.	Name of Mine.	Location.	P.O. Address of Manager, etc.
S. W. Ray	Tip-Top	Kashabowie	Port Arthur.
Fallahay and Walter		Strathy tp.	North Cobalt.
A. W. Jackson and H. G. Watkins	Rand Syndicate	Milepost 76, T. & N.O. Ry.	Timagami.
Mine Centre Copper Co.		Mine Centre	Port Arthur.
Sable River Copper Co.	Massey	Sault Branch, C.P. Ry.	
Gould Township Copper Syndicate	Cheney	Gould tp.	Montreal.

Nickel

The year 1916 surpassed any previous one in the production of nickel. There were turned out of the convertors of the Canadian Copper Company and the Mond Nickel Company 80,010 tons of Bessemer matte, the metallic contents of which were 41,299 tons of nickel and 22,430 tons of copper, the matte thus averaging 51.6 per cent. nickel and 28 per cent. copper. As is well known, the mattes produced by these companies differ in the proportions of nickel and copper which they respectively contain. The product of the Canadian Copper Company for last year carried an average of 54.8 per cent. of nickel and 24.0 per cent. of copper, while that of the Mond Nickel Company carried 39.2 per cent. of nickel and 43.3 per cent. of copper. The difference is in large measure due to the composition of the ores treated by the companies. The great Creighton mine which furnishes the bulk of the ore charged into the Copper Company's furnaces is rich in nickel and of fair copper tenor, while the Mond Company's ores have so far contained more copper than nickel.

The ore raised by the Canadian Copper Company from its several mines was as follows:—

	Tons.
Creighton	984,306
Crean Hill	175,000
No. 2	65,651
Vermilion	2,230
Total	1,227,187

Mond Nickel Company:—

	Tons.
Garson	115,392
Victoria No. 1	56,123
Worthington	78,280
Levack	61,284
Total	311,079

The latter also received from the Alexo mine in Dundonald township, 8,288 tons.

The quantities of ore smelted by the respective companies were: Canadian Copper Company 1,167,070 tons; Mond Nickel Company 351,619 tons.

The nickel constituents of the silver ores of Cobalt have not hitherto bulked largely in the nickel production of Ontario, and in point of quantity, they cannot in comparison be regarded as of great importance. Nevertheless, the metallurgical industry depending upon the ores of Cobalt for its raw material has been obliged to deal with the nickel in these ores, and can claim the credit for having produced the first refined metallic nickel made in the Province. At the works of the Deloro Smelting and Refining Company the refined oxide of nickel is smelted in an electric furnace into metallic nickel, of which 79,360 pounds were produced during the year and 42,114 pounds shipped at an average price per pound of 42 cents. Besides yielding metallic nickel, the refineries at Deloro, Thorold and Welland, as already stated in dealing with the silver ores of Cobalt, have produced considerable quantities of refined oxide and nickel sulphate. Details will be found on a previous page.

The production in Ontario of refined nickel and copper on a large scale from the ores of the Sudbury district will soon be an established fact. The International Nickel Company of Canada has been engaged since early in the year in the erection of a refining plant at Port Colborne, where it is intended to treat a considerable part of the Bessemer matte produced at the Canadian Copper Company's works at Copper Cliff. The capacity of the plant at the outset will be 7,500 tons of nickel and a corresponding quantity of copper per annum, but it is expected that in the normal development of the business it will be found desirable to increase the capacity of the plant from time to time.

The British America Nickel Corporation, Limited, is engaged in developing the Murray mine near Sudbury, where a large deposit of ore has been located. A smelter is also in course of construction at the same place. Actual work has not yet been begun on the company's refinery, the initial difficulties regarding the provision of a sufficient supply of hydro-electric power not yet having been overcome.

Report of Royal Ontario Nickel Commission

It is unnecessary to go into details here regarding the nickel industry of Ontario in view of the recent publication of the Report of the Royal Ontario Nickel Commission, which covers the subject practically in all its phases, and deals also with nickel mining and known nickel deposits in all other parts of the world.*

The chapter headings give an idea of the scope of this report. They are as follows: Summary and Conclusions; Agitation for Home Refining of Nickel; The Operating Nickel Companies; Nickel Deposits of the World; Properties and Uses of Nickel and Its Compounds; Non-Ferrous Nickel Alloys; Nickel Steel and Other Nickel Alloys Containing Iron; Smelting Nickel Ores; Refining Processes; Recovery of Metals of the Platinum Group; Recovery and Utilization of Sulphur; Statistics; Taxation of Mines and Mining Industries; Bibliography of Nickel. The Appendix contains the testimony of witnesses who appeared before the Commission together with memoranda, written arguments and other papers submitted by those interested in the subject of the Commission's inquiry, or any part of it. An instrument under the Great Seal of the Province dated 9th September, 1915, directed the Commissioners to inquire into and make report upon "the resources, industries and capacities, both present and future, of this Our Province in connection with Nickel and Its Ores, and at the same time into and upon a just and equitable system of taxation by Our said Province of the mines, minerals and mineral industries thereof." More particularly enumerating the subjects of inquiry, the Commission declared them to be:

(*a*) The modes of occurrence, deposits, supply, mining products, by-products and alloys of nickel in Our said Province and elsewhere, together with the present probable and possible uses thereof, and of such products, by-products and alloys.

(*b*) The smelting, refining, and manufacture of nickel, its ores, products, by-products and alloys within Our said Province and elsewhere, with special reference to treatment, refinement, and employment and uses thereof within the said Province;

(*c*) The demand and market for nickel, its ores and products, by-products and alloys;

(*d*) Nickel and allied industries with their probable development and requirements, and with special reference to their extension and development within Our said Province;

(*e*) Such matters as in your opinion will assist Our Lieutenant Governor in Council to provide a system of taxation upon mines, mining lands, claims or rights, minerals and industries connected with mining that will be just and equitable and in the best interests of Our said Province;

(*f*) Such further and other matters as in your opinion may relate to or have any bearing upon any of the foregoing subjects of inquiry, having regard to the best interests of this Our Province and of Our Dominion of Canada and of Our Empire.

It will suffice for these pages to quote the conclusions at which the Commissioners arrived on the principal phases of their investigations. They say:—

The two questions that have been uppermost in the numerous discussions that have taken place concerning Ontario's nickel industry during the last twenty five years are: (1) Can nickel be economically refined in Ontario? (2) Are the nickel deposits of Ontario of such a character that this Province can compete successfully as a nickel producer with any other country? It will be seen that the Commissioners have no hesitation in answering both of these questions in the affirmative.

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*Royal Ontario Nickel Commission, Report and Appendix; A. T. Wilgress, Printer to the King's Most Excellent Majesty, Toronto, 1917. Report and Appendix contain in all over 900 pages, also numerous cuts, maps, and plans. The commissioners were George T. Holloway, Associate of the Royal College of Science, and Vice President of the Institution of Mining and Metallurgy, London, England, Chairman; Willet Green Miller, Provincial Geologist, Toronto; McGregor Young, K.C., Toronto, and Thos. W. Gibson, Deputy Minister of Mines, Toronto, Secretary.

The Commissioners are of opinion:

1. The nickel ore deposits of Ontario are much more extensive and offer better facilities for the production of nickel at a low cost than do those of any other country. Nickel-bearing ores occur in many parts of the world, but the great extent of the deposits in this Province, their richness and uniformity in metal contents, and the success of the industry point strongly to the conclusion that Ontario nickel has little to fear from competition.

2. Any of the processes now in use for refining nickel could be successfully worked in Ontario, and conditions and facilities are at least as good in this Province as in any other part of Canada.

3. In view of the fact that practically no chemicals are required, that there is a much more complete saving of the precious metals, especially platinum and palladium, and that electric power is cheap and abundant, the most satisfactory method of refining in Ontario will be the electrolytic.

4. The refining of nickel in Ontario will not only benefit the nickel industry, but will promote the welfare of existing branches of the chemical and metallurgical industries, and lead to the introduction of others.

5. The methods employed at the Ontario plants of the two operating companies are modern and efficient, although there are differences in both mining and smelting practice. It is the consistent policy of both companies to adopt all modern improvements in plant or treatment. Even during the present time of acute pressure the Canadian Copper Company has materially increased its output without substantial enlargement of its plant, and the losses in smelting are less both at Copper Cliff and the Mond plant at Coniston than they were a year ago. These companies have each had their experimental stage, neither has asked nor received any government assistance, and both have earned the success which they have achieved.

6. The present system of mining taxation in Ontario is just and equitable and in the public interest, and is the best system for this Province. Any question of change is one of rate rather than of principle. This important question is dealt with at length in Chapter XIII.

Prof. G. A. Guess' Nickel-Refining Process

As is well known, there are three processes employed for the refining of nickel-copper mattes, such as are produced at Sudbury. These are the Orford, the Mond and the Hybinette, respectively, of which the last named alone is electrolytic.

During recent years great progress has been made in the electrolytic refining of various metals. Mention need be made only of the case of zinc, the metallurgy of which has been greatly changed by the successful application of an electrolytic process.

In a country like Ontario where a local supply of chemicals, such as are used in the Orford process, is lacking or expensive, and coal is not produced, but where hydro-electric power is cheap and abundant, electrolytic processes are the most attractive.

With the object of evolving a nickel refining process, that would meet, as far as possible, the conditions prevailing in Ontario, the Royal Ontario Nickel Commission secured the services of Prof. G. A. Guess, of the metallurgical department of the University of Toronto, to investigate the question of refining. He has developed an electrolytic process, for which patents have been secured, that is believed to be of commercial importance. The advantages of such a process are that it employs only small quantities of chemicals, deleterious waste liquors are not produced, and the precious and rare metals—platinum, palladium, iridium, gold, silver and others—are practically entirely saved. This is of great moment now that platinum is at least five times as valuable as gold, and is essential in certain industries which under present conditions are of fundamental importance.

An outline descriptive of Prof. Guess' process is given in his own words in the following paragraphs:

An investigation was carried out for the Royal Ontario Nickel Commission looking toward the working out of an electrolytic refining process for nickel from copper-nickel mattes.[*]

Briefly, the process was as follows: the matte is crushed to about 20-mesh, roasted to remove sulphur, and leached with 10 per cent. sulphuric acid solution, which extracts about 50 per cent. of the copper and a very small amount of the nickel. The leached residues are dried, reduced and cast into anodes, which are referred to as soluble anodes. The leached liquor is electrolyzed with the soluble anodes to produce electrolytic copper, until the copper content of the electrolyte has reached about 1.5 per cent. copper; beyond this point an impure cement copper is produced at the cathode. Electrolysis is continued for the solution of the copper-nickel anode and the depletion of the copper in the electrolyte, until it is reduced to about 0.05 per cent., or 0.5 grammes copper per litre.

The electrolyte runs next to other tanks containing insoluble lead anodes, and electrolysis continued until the copper content is reduced to 0.013 per cent., or 0.13 grammes per litre.

After the elimination of the copper, and if necessary the small amount of iron, this electrolyte is heated and electrolyzed with insoluble lead anodes, at a very high current density, about 250 amperes per square foot. About half the nickel may be recovered as electrolytic nickel before the solution becomes too acid for economic production of nickel. The acidity is corrected by running the solution to the soluble anode tanks again, or by evaporation and cropping of nickel sulphate crystals, and the use of the acid mother liquor for leaching purposes.

As pointed out in the Nickel Commission's Report,[†] there was required a certain quantitative relation of copper to nickel in the matte, in order to not accumulate in the process an excess of the soluble anodes. Further work, since the Report, shows how it is possible to control the quantity of soluble anodes to be made.

The percentage of metals extracted from the roasted matte may be increased, and therefore the anode-making material reduced, in two ways, as described in the following tests, the culmination of the result of several experiments.

Copper-nickel matte of the following composition was used: Copper 40.2 per cent., nickel 40.1 per cent., sulphur 18.2 per cent.

1. The matte was crushed to 100-mesh; after roasting for three hours at a low red heat, it was removed and the loosely agglomerated mass rubbed to a powder; roasting was then continued at gradually increasing temperatures up to 800 deg. C. for 30 hours. The water-soluble extraction of the calcines was 22.0 per cent. of the copper and 39 per cent. of the nickel. The extraction with 10 per cent. sulphuric acid solution was 40 per cent. of the nickel and 90 per cent. of the copper.

2. The matte was crushed to 20-mesh and screened through 20 and on 40-mesh. After roasting two to three hours at a low heat it was reground to break up the loosely formed cake. This was re-roasted for three hours at 900 deg. C. It showed no extraction with hot water. The calcines were mixed with twice their weight of hot strong sulphuric—half water, half strong acid by volume—and the mass later extracted with five volumes of water. There was extracted 33.7 per cent. of the nickel and 79.0 per cent. of the copper; 10 per cent. acid solution extracted from these calcines contained practically no nickel and only 40 per cent. of the copper.

Either of these methods would leave a very much reduced quantity of anode-forming metal, and give all the control desired over the quantity of anodes to be made.

A refining operation as above carried out on these mattes yielded 68 grammes of dried slime from the electrolytic soluble anode tank. These slimes had the following analysis:—

Cu. 13 per cent., Ni. 16.2 per cent, S. 27.2 per cent., Fe. 0.1 per cent., Insol. 1.5 per cent.

The precious metal content was as follows:

	Ozs. per ton slime.	Ozs. per ton original matte.
Silver	290.0	7.69
Gold	8.3	.22
Platinum	32.9	.872
Palladium	16.8	.446

[*] Report Royal Ontario Nickel Commission, p. 479.
[†] P. 480.

The progress of the nickel-copper mining and smelting industry for the last five years is summed up in the following table:

TABLE VIII.—NICKEL-COPPER MINING AND SMELTING, 1912-1916.

Schedule.	1912	1913	1914	1915	1916
Ore raised	737,656	784,697	1,000,364	1,339,322	1,572,804
Ore smelted	725,065	823,403	947,053	1,272,283	1,546,215
Bessemer matte produced	41,925	47,150	46,396	67,703	80,010
Nickel contents of matte	22,421	24,838	22,759	34,039	41,299
Copper contents of matte	11,116	12,938	14,448	19,608	22,430
Value of Nickel in matte $	4,722,040	5,237,477	5,108,997	17,019,500	20,619,279
Value of Copper in matte $	1,581,062	1,839,438	2,080,034	3,921,600	8,299,051
Wages paid $	2,357,889	3,291,956	3,131,520	3,581,639	4,920,720
Men employed	2,850	3,512	3,464	4,178	4,730

The quantity of coke used as fuel was 181,520 tons worth $1,163,703, and of wood 26,655 cords worth $95,726. Of the wages paid $2,903,876 was for mining, and $2,016,844 for smelting.

The price of refined nickel on the New York market was quoted at 45 to 50 cents per pound, 5 cents per pound additional being asked for the electrolytic article.

The growth of nickel and copper production at Sudbury from the beginning of the industry is shown by the subjoined diagram.

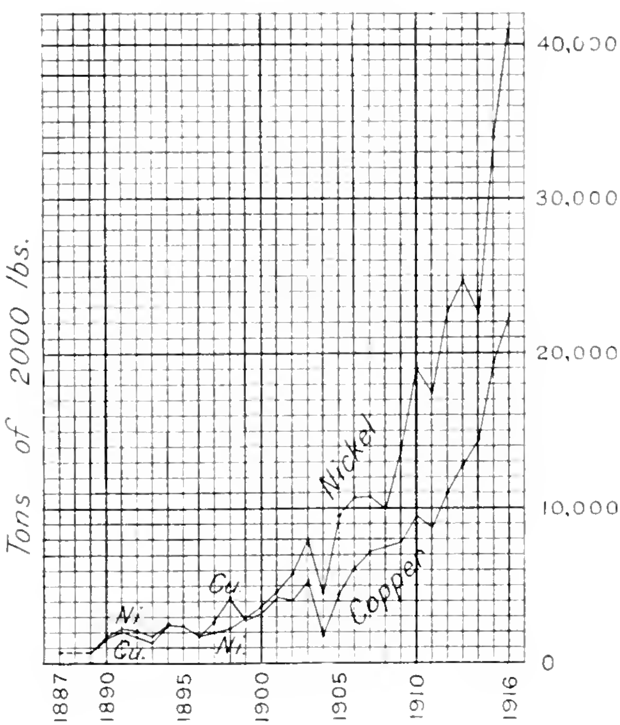


Diagram showing tonnage of nickel and copper produced in the Province from 1887 to 1916.

The companies engaged in mining, or in mining and smelting, nickel-copper ore during the year 1916 were as follows:—

NICKEL COPPER PRODUCERS IN 1916

Name of Company.	Name of Mine.	Location.	P.O. Address of Manager, etc.
Canadian Copper Company	Creighton, Crean Hill, etc.	Sudbury	Copper Cliff.
Mond Nickel Company, Limited	Garson, Levack, etc.	Sudbury	Coniston.
A. D. Carmichael	Howland	Sudbury	Bruce Mines.
The Alexo Mining Co., Limited	Alexo	Dundonald tp.	Porquis Junction.

Cobalt

Particulars have already been given regarding the production of cobalt from the silver mines of the camp to which it has given its name, and the forms in which it is obtained in the refineries. The raw material for these plants is the ore as it comes from the ground, the concentrates produced by gravitation and flotation methods, and the residues from the mills at Cobalt in which merchantable bars are made. The Nipissing plant, for instance, was a large shipper of such residues.

Until recently the principal use of cobalt was in the manufacture of china and pottery, for imparting the beautiful colour known as "cobalt blue." Samples of glass and other ware coloured in this way have come down from remote times, and the manufacture of cobalt for colouring purposes was a well-known industry in Saxony three hundred years ago.* For such use it is first obtained as the oxide, and then usually transformed into smalt or cobalt glass.

The great development which has taken place within the last few years in the study and production of alloys for special purposes has included cobalt. Metallic cobalt has been found to exert a beneficial action on steel similar to that of nickel, of which it is in nature a close ally. For electro-plating metallic objects in place of nickel, it seems to possess many desirable qualities, except perhaps the important one of cheapness. But cobalt has obtained much success as a component, along with chromium and tungsten, of the alloy known as "stellite," one of the principal uses of which is as metal for high speed tools. Stellite is the invention of Elwood Haynes, of Kokomo, Indiana, and it is rapidly coming into favour for the machining of steel, owing to its hardness, durability and persistency of temper. Much of the metallic cobalt produced in Ontario is for use in making this alloy, which is itself made by the Deloro Smelting and Refining Company in quantities sufficient to supply the Canadian market.

* See Rep. Ont. Bur. Mines, Vol. XIX, Pt. II, p. 231, The Early History of the Cobalt Industry in Saxony, Translation by G. R. Mickle.

Iron Ore, Pig Iron and Steel

The Helen and Magpie mines, in the Michipicoten area, owned by the Algoma Steel Corporation, were the only producers of iron ore in 1916. Consignments from the Helen amounted to 109,965 tons, of which 45,544 tons of hematite went to Sault Ste. Marie for use in the Steel Corporation's blast furnaces there, and 64,421 tons of high sulphur ore to the Magpie mine, where it was dumped down through a raise and blended with ore from the Magpie. When treated in the roasting furnaces at the Magpie, this mixture produced a Bessemer grade of ore.

From the Magpie the shipments amounted to 210,522 tons. Of this 89,027 tons went to the Corporation's plant at the Sault, and the remainder to five different consignees at Cleveland, Buffalo and Milwaukee. The total quantity of ore raised at the Magpie was 233,143 tons; of this about 49,000 tons consisted of the ore brought for treatment from the Helen, leaving about 15,000 tons of the latter still in the mine. The roasted product from the Magpie plant contains about 53 per cent. of iron, and is in high favour with ironmasters in the United States. It carries about 2 per cent. of manganese, and works well in the furnace.

The total quantity of iron ore marketed during 1916 was 256,063 tons, of which 121,495 tons were exported to the United States. Most of the ore made into pig iron in this Province is brought from south of the line, and to some extent no doubt the imports and exports are influenced by the needs of blast furnaces for special grades of ore.

There was an advance of 75 cents per ton in the price of iron ore, as fixed by the market for the Great Lakes product in the United States, and the price for 1917 is to be $1.50 more than that for 1916.

The only company mining iron ore last year was The Algoma Steel Corporation, Limited, which operates the Helen and Magpie mines, and whose head office is at Sault Ste. Marie.

There were seven blast furnaces in operation in 1916, the aggregate output of which was 699,202 tons of pig iron valued at $9,739,701. Of the ore smelted 215,366 tons were from Ontario mines, and 1,056,810 tons were imported from the United States; 17 per cent. only of the total ore used therefore being of domestic origin. The Algoma Steel Corporation at Sault Ste. Marie had three furnaces in operation, the Steel Company of Canada at Hamilton two, and the Canadian Furnace Company, Port Colborne, and Standard Iron Company, Deseronto, one each. Scale and mill cinder were charged into the furnaces to the extent of 25,535 tons. All the plants smelt with coke, except the Standard Iron Company, which uses charcoal. The companies operating with coke return their pig iron product at an average value of $13.34 per ton, while the charcoal pig is valued at $21.46 per ton.

Of the total pig iron produced 465,623 tons were used in making steel, the entire output of which was 686,959 tons. The urgent requirements of the war include none more urgent than that for steel, and the furnaces of this Province have been doing their "bit." In 1915 the total pig iron product was 493,400 tons, of which 329,974 tons were used in making steel, the production of which amounted to 471,059 tons. The increase for 1916 in the tonnage of pig iron produced was 41.7 per cent., and in total steel made 45.8 per cent.

There is in course of erection in the Toronto harbour industrial area, for the Imperial Munitions Board an electric steel and forging plant with an initial capacity of 300 tons of steel daily. The concern known as Imperial Forgings, Limited, will employ ten electric furnaces of the Heroult type, using about 20,000 horse power.

The works of the Electro Metals, Limited, at Welland, turned out a large quantity of ferro-silicon, using as raw materials silica, ganister rock and pyrites ore cinder.

Following are particulars of the iron and steelmaking industry of the Province for the last five years:—

TABLE IX.—PRODUCTION IRON AND STEEL, 1912 TO 1916

Schedule.	1912	1913	1914	1915	1916
Ontario ore smelted ....tons	71,589	132,708	163,779	293,305	215,366
Foreign ore smelted .... "	1,062,071	1,095,561	752,560	623,094	1,056,810
Limestone for flux .... "	305,509	351,741	252,258	215,686	296,988
Coke .... "	660,248	706,852	590,902	486,022	708,273
Charcoal ....bush	1,886,748	2,206,191	920,045	1,314,957	1,843,209
Pig iron produced ....tons	589,593	648,899	556,112	493,400	699,202
Value of pig iron produced ...... $	8,054,369	8,719,892	7,041,079	5,910,625	9,739,704
Steel made ....tons	457,817	648,948	479,320	471,059	686,959
Value of steel made .... $	8,071,339	11,230,109	7,786,303	7,618,272	12,847,309

The following companies operated blast furnaces in 1916:—

IRON BLAST FURNACES IN OPERATION, 1916

Name of Company.	No. of Furnaces operated.	Fuel used.	Location.
Algoma Steel Corporation, Limited.	3	Coke.	Sault Ste Marie.
Canadian Furnace Company, Ltd...	1	Coke.	Port Colborne.
Standard Iron Company, Limited ..	1	Charcoal.	Deseronto.
Steel Company of Canada, Limited.	2	Coke.	Hamilton.

Lead

At the Galetta mine owned and operated by the Estate of James Robertson, Montreal, where a smelter has been erected, some 6,181 tons of lead ore were raised last year, the concentrates resulting from which amounted to 1,032,559 pounds. No ore was raised at the Hollandia mine, near Bannockburn, but about 50 tons of concentrates were produced. At the works of the Kingston Smelting Company, Limited, over 43 tons of concentrates were smelted. The lead contained in these several lots of concentrates was 796,833 pounds valued at $70,863. This is at 8.7 cents per pound, the average price in Montreal for the year being 8.513 cents per pound, and in New York and St. Louis 6.8 cents. The number of employees in lead mining and smelting was 65, who were paid in wages $35,811. The galena raised at the Galetta mine is only slightly argentiferous.

Molybdenite

Molybdenite is one of those minerals whose usefulness in making metal alloys for special purposes has recently brought them to the front. It is the sulphide of molybdenum, and is found sometimes in flat hexagonal crystals with cleavage not unlike that of mica, but with non-elastic, lead coloured, easily separable leaves; and sometimes disseminated in small crystals throughout the rock in which it occurs. Its most common occurrence in Ontario is in association with pegmatite dikes in gneiss or crystalline limestone.

Since tungsten supplies became scarce and ferro-molybdenum could no longer be procured from Germany, steelmakers in England have been using molybdenum in the manufacture of high speed tool steel, and the British government requisitioned all the molybdenite in the Empire, paying therefor at a rate equal to about \$1.00 per pound in Canada for concentrates containing 85 or 90 per cent. MoS_2. The urgency of the demand, and the price offered, have led to considerable search for deposits of molybdenite, and in last year's Report, pp. 17 to 21, the known deposits were enumerated by A. L. Parsons, of the University of Toronto, and particulars of their location and ownership given. Mr. Parsons' full report on Molybdenite in Ontario is printed in the present volume, and will be found of interest.

The Imperial Munitions Board, Ottawa, represents the Imperial authorities in purchasing and forwarding supplies of molybdenite concentrates. A plant for dressing the ore has been installed in connection with the Mines Department, Ottawa, and concentrators have been erected by the International Molybdenum Company at Renfrew, and by the Renfrew Molybdenum Mines Company at Mount St. Patrick. Ferro-molybdenum is also being made at Orillia and Belleville.

The production of molybdenite concentrates in Ontario last year amounted to 24,562 pounds, valued at \$26,392. About 893 tons of ore were treated for this quantity. Most of the concentrates were smelted into ferro-molybdenum at Orillia and Belleville, where also a considerable quantity from Quebec was treated. The concentrates from the Mount St. Patrick mill were shipped to France.

The production of concentrates from Ontario ore was as shown in the following table:—

MOLYBDENITE CONCENTRATES, 1916

Concentrator.	Tons ore treated.	Lbs. concentrates produced.
Mines Branch, Mines Dept., Ottawa	190.78	11,349
International Molybdenum Co., Ltd., Renfrew.	450.3	9,204
Renfrew Molybdenum Mines, Ltd., Mt. St. Patrick	86.0	1,248
William J. Spain, Dacre	165.9	2,761
Total	892.98	24,562

The producers of molybdenite ore in 1916 were as follows:—

MOLYBDENITE PRODUCERS IN 1916.

Name.	Location of Deposit.	P.O. Address.
Horscroft, T.	Somerville township	Norland.
O'Brien, M. J.	Mount St. Patrick	Renfrew.
Offer, William C.	South Porcupine	South Porcupine.
Padwell, George	Monmouth township	Wilberforce.
Renfrew Molybdenum Mines, Limited	Brougham township	Grand Mere, Que.
Spain, William J.	Dacre	417, Fifth Avenue, New York.
Todd, Frederick G.	Mount St. Patrick	801 New Birks Bldg., Montreal.
Urquhart, W. J.		Toronto.

Construction Materials

Owing to the scarcity and high cost of labour in 1916 many branches of the building trade were hampered in their operations. There was also a decided falling-off in the demand. In consequence a considerable reduction is recorded in the output, particularly of brick and tile. Over 100 operators reported that their yards had been closed for the year, and the remainder, for the most part, worked on a much reduced scale. The sewer pipe trade experienced similar conditions. The value of the output has increased for the following items: stone, lime, sand and gravel.

Brick, Tile, Sewer Pipe and Pottery

The following table shows the comparative value of the output of clay products since the outbreak of war:—

Year.	Brick.		Pottery.	Drain tile.	Sewer pipe.	Total.
	Common.	Pressed, Fancy, Terra Cotta, etc.				
	$	$	$	$	$	$
1914	2,336,207	894,384	25,720	277,530	571,756	4,105,597
1915	763,591	375,865	49,387	321,253	361,283	1,871,379
1916	509,559	495,895	87,025	275,471	216,749	1,584,699

By far the larger part of the brick manufactured in Ontario is from clay or shale. Sand-lime brick have fallen off in production. Hollow tile construction is on the increase, both for fireproof walls in large buildings and in house construction. Hollow tile are sold by the thousand and also by weight. The 1916 output was worth $176,955. Cement brick and blocks are considered under the heading "Cement."

Fuel costs for burning brick have greatly advanced. The generally increased cost of production has raised the average price of common brick at the works from

$7.96 per thousand in 1915 to $8.43 in 1916. The wages paid in 1916 amounted to $172,011, and the industry employed 1,329 men.

Although some of the larger brickyards operate practically the year round, the season for the small plants is a short one. The average run in 1916 was 109 days, the same as for the preceding year.

Following is a list of the brick and tile operators who had an output in 1916:

BRICK AND TILE PLANTS.

Name.	Address.	Product.
Alvinston Brick & Tile Co., Limited	Alvinston	Brick and Tile
Armstrong Bros.	Fletcher	Tile.
Attercliffe Standard Brick, Block & Tile Co.	Attercliffe	Tile.
Baird & Son, H. C.	Parkhill	Brick and Tile.
Baker, Geo. E.	Arnprior	Brick and Tile.
Bell Bros.	Paisley	Brick and Tile.
Bemrose, Thos.	Beeton	Brick and Tile.
Bogart Bros.	Southwold	Brick and Tile.
Bond & Bird	Woodstock	Brick.
Brampton Pressed Brick Co., Ltd.	Brampton	Pressed Brick.
Broadwell & Son, B.	Kingsville	Brick, Tile, and Hollow Blocks.
Brown, J. W.	Vienna	Tile.
Brownscombe & Sons, H.	Cargill	Brick and Tile.
Brownscombe, E. N.	Paisley, R.R. No. 2	Tile.
Buck, J. L.	Port Rowan	Brick and Tile.
Butwell, Henry	Toronto	Brick.
Cabana, Jr., Oliver	Zurich	Brick and Tile.
Campbell, Neil F.	West Lorne	Brick and Tile.
Canadian Pressed Brick Co., Limited	Hamilton	Pressed Brick.
Clark, Walter	Corunna	Brick and Tile.
Clemens, Moses	Thamesville	Brick and Tile.
Cooper, W. H.	Hamilton	Brick.
Cornhill Sons, Ltd.	Chatham	Brick.
Crawford Bros.	Hamilton	Brick.
Cumberland, J. M.	Listowel	Tile.
Curtin, Frank	Lindsay	Brick.
Curtis Bros.	Peterboro'	Brick and Tile.
Deller & Sons, Geo.	Norwich	Brick and Tile.
Deller, Wm. H.	Thorndale	Tile.
Dockart Brick & Tile Works	Arnprior	Brick and Tile.
Dolan, John	Watford, R.R. No. 2	Tile.
Dominion Sewer Pipe Co., Limited	Waterdown	Brick and Tile.
Donaldson Bros.	Harriston, R.R. No. 4	Brick and Tile.
Don Valley Brick Works	Todmorden	Common, Pressed and Fancy Brick, Porous Hollow Blocks, etc.
Elliott, Chas.	Bluevale	Tile.
Elliott & Sons, Jas.	Steelton	Brick.
Entricken, F. W.	Tavistock	Tile.
Fox, G. J.	Dresden	Brick.
Frank, E. D.	Strathroy	Brick and Tile.
Fraser, Chas.	Blyth	Brick and Tile.
Frid Bros.	Hamilton	Brick.
Frost, Geo. H.	Toronto	Brick.
Fuller, Geo.	Belwood, R.R. No. 2	Tile.
Gardiner, William	Blenheim	Brick and Tile.
Govenlock, J. M.	Seaforth, R.R. No. 1	Tile.

BRICK AND TILE PLANTS.—*Continued.*

Name.	Address.	Product.
H[illegible], H.	Comber	Brick and Tile.
Hamilton Pressed Brick Co., Limited	Hamilton	Pressed Brick.
Handley, R. H.	Bowmanville	Tile.
Henderson & Angus	North Bay	Brick.
Hepworth Silica Pressed Brick Co., Ltd.	Hepworth	Pressed Brick.
Hill Brick Co.	Madoc	Brick and Tile.
Hill, Aaron	Essex	Tile.
Hill, A. W.	Coatsworth, R.R. No. 1	Tile.
Hinde Bros.	West Toronto	Brick.
Hiscock & Sons	Cobourg	Brick.
Hitch, Mrs. Susan	Ridgetown	Brick and Tile.
Hitch, Thos.	St. Thomas	Brick and Tile.
Hohl & Sons, Geo.	Lisbon	Brick and Tile.
Holland & Son, William	Ruscomb	Brick and Tile.
Holton, F. C.	Clifford, R.R. No. 3	Brick.
Holton, R. J.	Clifford, R.R. No. 3	Tile.
Howlett & Sons, Fred.	Petrolia	Tile.
Interprovincial Brick Co. of Canada, Ltd.	Cheltenham	Pressed Brick.
Irwin Estate, Jas.	Norwich	Brick.
James, W. B.	Mitchell	Brick and Tile.
Jaynes, D. A.	Delaware	Brick and Tile.
Jasperson, B.	Kingsville	Brick and Tile.
Jervis & Son, John	Dorchester Station	Brick and Tile.
Johnson, James	Pembroke, R.R. No. 3	Brick.
Johnston, Jos.	West Monkton	Brick.
Jordan, D.	Chatham	Brick and Tile.
Kaar, John	Brownsville	Brick and Tile.
Kerr, Chas	Goderich, R.R. No. 4	Brick and Tile.
Koebel, Joseph Z.	St. Clements	Tile.
Kruse Bros.	Egmondville	Brick and Tile.
Kuhn, Henry J.	Crediton East	Tile.
Lasey & Son, Geo. A.	Foxboro'	Tile.
Leamington Brick & Tile Co., Ltd.	Leamington	Brick and Tile.
Lindsay, Stephen	Wallaceburg, R.R. No. 2	Tile.
Lingham, W. T.	Belleville	Brick.
Logan, John	Toronto	Brick.
Lowe, Jos.	Meaford, R.R. No 1	Tile.
Lowes, Gordon	Kent Centre	Brick and Tile.
MacKay Bros.	Dutton	Tile.
McCormick Bros. & Son	Watford	Tile.
McCredie & Reid	Lyons	Brick and Tile.
McGibbon, Dugald	Shedden	Tile.
Marshall, W. W.	Woodstock	Brick and Tile.
Martin, David	Thamesville	Brick and Tile.
Meaford Brick Co., Limited	Meaford	Brick.
Milton Pressed Brick Co., Ltd.	Milton	Pressed and Fancy Brick.
Miner, J. T.	Kingsville	Brick and Tile.
Mobley, Walker	Toronto	Brick.
Napanee Brick & Tile Co., Limited A. F. Clark, lessee	Napanee	Brick and Tile.
National Fire Proofing Co. of Canada, Limited	Aldershot	Tile, Fancy Brick and Hollow Blocks.
Noa, Edward	Hamilton	Brick.
Norton, Alsey	Bolton	Brick and Tile.
Oden & Sons, Wm.	Ingersoll	Brick and Tile.
Ontario National Brick Co., Limited	Cooksville	Brick.

BRICK AND TILE PLANTS.—*Continued.*

Name.	Address.	Product
Ontario Paving Brick Co., Limited	West Toronto	Paving Brick and Blocks
Ott Brick & Tile Mfg. Co., Limited	Kitchener	Brick.
Ottawa Brick Mfg. Co., Limited	Ottawa	Brick.
Owen Sound Brick Co., Limited	Owen Sound	Brick.
Parks, H. W.	Dresden	Tile.
Paxton & Bray	St. Catharines	Brick.
Pears & Son, James	Toronto	Brick.
Pembroke Brick Co., The	Pembroke	Brick.
Phillips & Son, Thos.	St. Helen's	Brick and Tile.
Phinn, Geo. E.	Lucan	Brick and Tile.
Port Credit Brick Co., Limited	Port Credit	Common and Pressed Brick.
Price Estate, John	Toronto	Brick.
Provincial Secretary's Department	Mimico	Drain, Floor and Hollow Tile; Brick.
Richardson & Son, James	Kerrwood	Tile.
Ries, John	Carlsruhe	Brick and Tile.
Russell, Joseph	Toronto	Brick.
Sadler, F. L.	Dublin	Brick and Tile.
Silicate Brick Co. of Ottawa, Ltd.	Ottawa	Sand Lime Brick.
Sipprell, J. H.	Wilkesport	Tile.
Smith Bros.	Port Elgin	Brick.
Snelgrove & Teer	Beaverton	Brick and Tile.
Southorn, Geo.	Coldwater	Brick.
Stickwood, Chas.	Newmarket	Brick.
Stonehouse, W.	West Toronto	Tile.
Strathmeyer, E. F.	London	Brick.
Streetsville Brick Co., Limited	Streetsville	Brick.
Sudbury Brick Co., Limited	Sudbury	Brick.
Sun Brick Co., Limited	Toronto	Fancy Brick and Hollow Blocks.
Thornton, John	Perth	Brick.
Toronto Brick Co., Limited	Toronto	Sand Lime Brick.
Wagstaff, A. H.	Toronto	Brick.
Wagstaff, Chas.	Lindsay	Brick and Tile.
Waite, J. E.	Foresters Falls	Brick and Tile.
Wallace & Son, R.	North Bay	Brick.
Wallaceburg Brick Co.	Wallaceburg	Brick.
Watson Brick Co.	Bracebridge	Brick and Tile.
Wehlann, Alfred	Cairo	Brick and Tile.
Wehlann, J. A.	Rodney, R.R. No. 2	Tile.
Wood, W. H.	Brockville	Brick.
Wright, J. C.	Proton	Brick and Tile.
Yaeck, Louis	Walkerton	Brick and Tile.

Sewer Pipe

Three companies made sewer pipe to the value of $206,904 in 1916. Allowing for stocks on hand at the beginning and end of the year, the net production marketed was $216,549. Employees numbering 169 were paid in wages $111,641.

Following is a list of the companies:—

Name of Company.	Location or Plant.	P.O. Address of Manager, etc.
Dominion Sewer Pipe Co., Ltd.	Swansea	Swansea.
Hamilton & Toronto Sewer Pipe Co., Ltd.	Hamilton	Hamilton.
Ontario Sewer Pipe Co., Ltd.	Mimico	Mimico.

Pottery

Only the rougher grades of pottery are manufactured in this Province, no deposits of fine grade clay having as yet been found. Scattered throughout Ontario are several pottery companies that retail imported goods or goods made from imported clays. In 1916 five different makers produced pottery worth $87,025 at the works. Wages amounting to $32,049 were paid 47 employees.

The following is a list of operators in 1916:—

POTTERY PLANTS, 1916.

Name.	Address.
R. Campbell's Sons	Lock St. South, Hamilton.
J. Cranston & Son	210 Dundurn St. South, Hamilton.
John Davis & Son	610 Merton St., Toronto.
Foster Pottery Company	Main St. West, Hamilton.
Geo. M. Taylor	Port Hope.

Lime

The production for 1916 was 1,453,254 bushels valued at $265,356, as compared with 1,340,394 bushels worth $244,953 for 1915.

Small producers are gradually going out of business, the demand for lime being met by larger and better equipped plants. Portland cement is replacing lime to a certain extent for some uses.

For firing the kilns, wood, coal and natural gas are used as fuel, the total value of which amounted to $92,107 in 1916. Employees engaged in lime manufacture numbered 242, and received $140,202 in wages.

Below are given the names of producers and the location of plants in Ontario:

LIME PRODUCERS, 1916.

Name of Owner or Company.	Location.
Annis, Geo.	Orillia, R.R. No. 3.
Beachville White Lime Co., Limited	Beachville.
Bergin, Patrick	Napanee.
Brown, E. A.	Owen Sound.
Cameron, W. M.	Carleton Place.
Canada Lime Company, Limited	Coboconk.
Chalmers, Mrs. Margaret	Owen Sound.
Chestnut, W. D.	Duntroon.
Christie, Henderson & Co., Limited	Puslinch, Kelso, Hespeler and Galt.
Contractors' Supply Co., Limited	Orangeville and Teeswater.
Delta Lime Co., Limited	Delta.
Dominion Sugar Co., Limited	Wallaceburg.
Elora White Lime Co.	Elora.
Fleiler, Edward	Fernleigh.
Gallagher Lime & Stone Co., Limited	Hamilton, R.R. No. 4.
Guest, Mrs. Myra	Ancaster.
Harvey, Limited, E.	Rockwood.
Higginson & Stevens	Hawkesbury.
Jamieson Lime Co.	Renfrew.
Jamieson, J. M.	Forrester's Falls.

LIME PRODUCERS, 1916. *Continued.*

Name of Owner or Company.	Location
Moore, Jas.	Foxmead.
MacKenzie Bros.	Lucknow, R.R. No. 5.
Marshall Lime & Cement Works, Jas.	Hamilton.
Robertson Co., Limited, D.	Milton.
Robillard & Son, H.	Ottawa.
Rubel Bros.	Jordan.
Smith, John S.	Inverhuron.
Standard Chemical Iron & Lumber Co., Limited	Eganville.
Standard White Lime Co., Limited	Beachville, Guelph, and St. Marys.
Toronto Lime Co., Limited	Limehouse and Dolly Varden.
Toronto Brick Company, Limited	Coboconk.

Portland Cement

The quantity sold in 1916 shows a small decline as compared with 1915. Building construction was hampered through scarcity of labour. Barrels of cement marketed were 2,143,949, valued at $2,212,133, while the 1915 figures were 2,302,242 and $2,531,537, respectively. The average price per barrel dropped from $1.10 to $1.05. Cement on hand at the end of year totalled 380,158 barrels.

The following cement plants operated in 1916:—

PORTLAND CEMENT PLANTS, 1916.

Name of Company.	Location of Plant.	P.O. Address of Manager, etc.
Canada Cement Company, Limited, Plant No. 5	Thurlow tp., near Belleville	Herald Bldg., Montreal, Que.
do do do No. 8	near Port Colborne	do do
The Hanover Portland Cement Co., Limited	Hanover	Hanover.
National Portland Cement Co., Limited	Durham	Durham.
The Ontario Portland Cement Co., Limited	Blue Lake	Brantford.
St. Marys Portland Cement Co., Limited	St. Marys	St. Marys.
Union Cement Co., Limited	Owen Sound	Owen Sound.

In addition to the manufacture of Portland cement from clay and limestone or marl, the making of cement brick and blocks for wall construction, and of cement tile for drains and culverts, has grown to some importance. For the year 1916 a full report of the industry was attempted for the first time. Through the co-operation of C. A. Millar, Inspector for the Workmen's Compensation Board, the names of a fairly complete list of operators were secured. Returns from these show that some 241 thousand brick and blocks worth $10,684 were produced, also 1,718 thousand tile and sewer pipe valued at $16,946. The industry employed 73 men who received $15,512 in wages, and the average duration of operating the plants was 109 days.

The following is a list of operators reporting to the Bureau of Mines:—

MANUFACTURERS OF CEMENT BLOCKS, BRICK AND TILE.

Name.	Address.	Product.
Alcock, R. B.	Brussels	Tile.
Andrews, S. J.	Clinton	Tile.
Begg, Jas.	Lindsay	Tile.
Benglass, Jas.	Bright	Tile.
*Brennan & Hollingsworth	Hamilton	Tile.
*Colvin, M. N.	Komoka	Blocks and Tile.
Corinthian Stone Co.	Guelph	Sills, Lintels, etc.
*Corlett, A. S.	Leamington	Brick.
Deline, L.	Enterprise	Blocks and Tile.
Deveney & Campbell	St. Marys	Blocks and Tile.
de Jersey, O. W.	Forest	Blocks.
Dillon, Jno.	Seeley's Bay	Blocks and Tile.
*Dominion Concrete Co.	Kemptville	
Fletcher and Sons, J. H.	Fonthill	Blocks.
Hay & Son, J. C.	Listowel	Tile.
Hoy, William J.	Prescott	Brick, Blocks and Tile.
Harper & Sons	Cobden, R.R. No. 1	Tile.
Hornsby, Jno. T.	Lindsay	Tile.
Hyndman, Jno.	Gorrie	Tile.
Iler Concrete Tile Co.	Arner	Tile.
Karr & Rose	Petrolia	Tile.
Kilgour, D. G.	Eganville	Brick and Blocks.
Kinzel & Son, Jos.	Preston	Brick, Blocks and Tile.
*McDougall Bros.	Beaverton	Tile.
McLenaghan, W. A.	Essex	Blocks and Tile.
McQueen, Alex.	Arthur	Tile.
Malcolm, Jno.	Fergus	Sills, Lintels and Tile.
Mitchell, Frank	Pickering	Tile.
Moore, D. G.	Ailsa Craig	Blocks and Tile.
Oil Springs Tile & Cement Co.	Oil Springs	Blocks and Tile.
Ord, John A.	Guelph, R.R. No. 3	Tile.
Pfaff, W. E.	Hensall	Blocks and Tile.
Philp, Wm.	Whitevale	Brick, Blocks and Tile.
Pinchin, J. H.	Clarkson	Tile.
Reid, Russel	Tiverton, R.R. No. 2	Tile.
Schmidt, J. T.	St. Jacobs	Brick, Blocks and Tile.
Schram, A. J.	Camlachie	Tile.
Smith, A. G. C.	Acton	Blocks and Tile.
Stickwood, Thos.	Sharon	Tile.
Taylor & Hall	Peterboro'	Blocks and Tile.
Webster Construction Co., Limited	London	Tile.
Williams, E. J.	Wheatley	Blocks and Tile.
Wyatt, W. J.	Cottam	Blocks and Tile.

*Idle in 1916.

Sand and Gravel

There is a considerable business done in the raising of sand and gravel, chiefly for construction and road-making purposes. The quantity obtained in 1916 was 170,963 cubic yards, valued at $212,123. The figures for 1915 were 670,510 cubic yards, worth $178,288; hence in 1916 there was a falling off in quantity, but an increase in value. Much of the material is taken from the beds of the great lakes and connecting rivers by means of "sand suckers" or dredges, and is in large part exported to lake ports in the United States, such as Detroit,

Cleveland and Buffalo. The St. Clair and Detroit rivers; off Point Pelee and Pelee island; at Port Maitland; near Strawberry island in the Niagara river; off the mouth of the Niagara river, and elsewhere, the sand and gravel brought down and deposited by current and wave action are availed of to supply the requirements of builder and roadmaker. In addition, the large number of sand and gravel pits on dry land are constantly being drawn upon for local needs of a similar kind. In most of the settled parts of Ontario these products of glacial activity are plentiful, but in the flat lands of the southwestern peninsula they are relatively scarce and consequently dear. Hence the importance of the large supplies found in the lake and river bottoms.

Regulations have been framed by which the Department of Lands, Forests and Mines is authorized to grant licenses for the removal of sand and gravel from deposits under the waters of the great lakes and tributaries, the license being operative until the 31st of December following their date, and payment of a stipulated charge per cubic yard being required. This charge varies according to the extent of the deposit, the distance from market, etc., running from three to twelve cents per cubic yard. Permission has been given to municipalities to take sand and gravel from adjoining lake beds without charge when required for the construction or improvement of roads. The revenue from sand and gravel licenses in 1916 amounted to $11,680.11.

Following is a list of the sand and gravel operators who have made returns to the Bureau of Mines for 1916:—

SAND AND GRAVEL OPERATORS, 1916.

Name.	Material.	Address.
Armstrong Supply Co., Limited	Sand and Gravel	Hamilton.
Barnes, William	Sand	Hamilton.
Barton Sand and Gravel Co., Limited	Sand and Gravel	Bartonville.
Battle, Jos.	Gravel	Thorold.
Cadwell Dredging Co., Limited	Gravel	Windsor.
Canadian Sand & Gravel Co., Limited	Gravel	Thorold.
Clifton Sand Company	Sand and Gravel	Stamford.
Cobourg & Baltimore Gravel Road Co.	Sand and Gravel	Baltimore.
Confederation Sand and Gravel Co., Limited	Sand	St. Catharines.
Constructing and Paving Co. of Ontario, Limited	Sand and Gravel	Toronto.
Crow, H. E.	Sand and Gravel	Chatham.
Downey & Sons, J. J.	Gravel	Sault Ste. Marie.
Empire Limestone Co.	Sand	Buffalo, N.Y.
Forwell, Jos. K.	Sand and Gravel	Kitchener.
Godson Contracting Co., Limited	Sand and Gravel	Toronto.
Goodale, Emerson	Sand and Gravel	Hamilton.
Gould, Francis E.	Gravel	Cleveland, O.
Hamilton Sand and Gravel, Limited	Sand and Gravel	Hamilton.
Hansen, H. C.	Sand and Gravel	Cleveland, O.
Johnson, H. L.	Sand	Toronto.
Kingston Sand and Gravel Co.	Sand	Kingston.
Lindsay, Corporation of	Sand and Gravel	Lindsay.
Lyons Fuel Co.	Gravel	Steelton.
Maple Sand, Gravel and Brick Co., Limited	Sand and Gravel	Toronto.
McMurray, Geo.	Sand and Gravel	London.
Niagara Sand Corporation	Gravel	Welland.
Ollman Bros.	Sand and Gravel	Hamilton.
Oneida Lime Co., Limited	Sand	Buffalo, N.Y.

SAND AND GRAVEL OPERATORS, 1916.—*Continued.*

Name.	Material.	Address.
Ontario Sand Company	Sand and Gravel	Niagara Falls.
Oshawa, Corporation of	Gravel	Oshawa.
Peterboro, Corporation of	Gravel	Peterboro.
Prescott, Corporation of	Gravel	Prescott.
Rideau Canal Supply Co.	Sand	Ottawa.
Roesand Company, Limited	Sand and Gravel	Erin.
Sand and Supplies, Limited	Sand and Gravel	Toronto.
Soo Dredging and Construction Co., Limited	Gravel	Sault Ste. Marie.
Soo Dredging and Towing Co.	Gravel	Sault Ste. Marie.
Stamford Sand Co.	Sand and Gravel	Niagara Falls.
United Fuel and Supply Co.	Gravel	Detroit, Mich.
Whiting & Son, R.	Gravel	Copleston.
Windsor Sand and Gravel Co., Limited	Sand and Gravel	Walkerville.
Windsor, Essex & Lake Shore Rapid Ry. Co.	Sand and Gravel	Kingsville.
York Sand and Gravel Co., Limited	Sand and Gravel	Toronto.

Stone

Classified according to variety rather than uses, the quarry products of the Province for 1916, together with comparative figures for 1915, were as follows:

—	Limestone.	Sandstone.	Trap.	Granite.	Marble.	Quartz.
	$	$	$	$	$	$
1915	587,000	5,500	32,100	15,500	10,600	142,354
1916	625,628	14,268	91,762	23,655	....	223,514

Limestone is by far the most important, both as to variety of uses and value of production. The above valuation does not include limestone quarried for lime manufacture. Trap is a hard, tough, volcanic rock admirably suited for road metal when crushed. It is used extensively also for concrete road construction, although cheaper varieties of crushed stone serve for most concrete work. Long freight hauls increase the price of trap to so high a figure as to prevent its use in certain parts of the Province. Granite is quarried chiefly for paving blocks. The ornamental marble in Ontario comes from Hastings and Lanark counties, while white marble is quarried in Hastings and Renfrew. It is unfortunate that the public is slow in its appreciation of the beautiful marble that may be had from Bancroft and elsewhere in the Province. In 1916 the production of marble was nil. A large part of the quartz produced is used by the Canadian Copper Co. as a smelter flux in the production of nickel-copper matte. In the Coniston smelter the Mond Company use quartz obtained from Bruce Mines. This quartz carries copper which is recovered in the nickel-copper matte. Electro-Metals, Limited, at Welland, employ quartz in considerable quantities in the manufacture of ferro-silicon.

Below are given the names of quarry operators in 1916, classified according to product:—

LIMESTONE AND SANDSTONE QUARRIES

Name of Owner, Firm or Company.	Location.	Kind of Stone.
Amherstburg Stone Quarry	Amherstburg	Limestone.
Beachville White Lime Co., Limited	Beachville	do
Bergin, Patrick	Napanee	do
Britnell & Co., Limited	Burnt River	do
Canada Crushed Stone Corporation, Limited	Dundas	do
Coast & Lakes Contracting Corporation	Windmill Point	do
Cook, J. S.	Wiarton	do
Canadian Towing and Wrecking Co., Limited	Port Arthur	Rubble.
Contractors' Supply Co., Limited	Orangeville	Crushed Limestone.
Crushed Stone, Limited	Kirkfield	do do
Empire Limestone Co., Limited	Sherkston	do do
Farr, Mrs. C. C.	Haileybury	Limestone.
Fretz, Jacob M.	Vineland	do
Gallagher Lime & Stone Company, Limited	Hamilton	do
Hagersville Contracting Co., Limited	Hagersville	do
Hagersville Crushed Stone Co., Limited	Hagersville	do
Hamilton, Corporation of	Hamilton	do, crushed.
Henderson Farmers' Lime Co.	Woodstock	do, ground.
Kennedy, R. C.	Guelph	Limestone.
Kingston, Corporation of	Kingston	do, crushed.
Lally Estate	Smithville	Limestone.
Longford Quarry Co., Limited	Longford Mills	do
MacDonald, Jos. H.	Point Anne	do
McMillan, Jos. H.	Dunbar	do
Markus, Ltd., Wm.	Pembroke	do
Marshall, James	Hamilton	do
Michigan Central Railway	Hagersville	do
Oliver-Rogers Stone Co., Limited	Owen Sound	do
Ontario Rock Co., Limited	Belleville	do
Ontario Stone Corporation, Limited	Uhthoff	do
Perkins, Geo. A.	Owen Sound	do
Point Anne Quarries, Limited	Point Anne	do
Queenston Quarry Co., Limited	St. Davids	do
Quinlan & Robertson	Crookston	Limestone.
Reid, C. F.	Odessa	do
Rideau Canal Supply Co., Ltd.	Ottawa	do, crushed.
Robertson, D., & Company, Limited	Milton	Sandstone.
Robillard, H., & Son	Ottawa	Limestone.
Roddy & Monk	Kingston	do
Rogers Company, F.	Terra Cotta	Sandstone.
St. Marys Horse Shoe Quarry, Limited	St. Marys	Limestone.
Standard Crushed Stone Company, Limited	St. Davids and Windmill Point	do
Standard White Lime Co., Limited	Beachville, Guelph, and St. Marys	do
Thames Quarry Company, Limited	St. Marys	do
Tietz, Wm. A.	Waterford, R.R. No. 1	do
Walker Bros.	Thorold	do
Welland County Lime Works Co., Limited	Port Colborne	do
Wentworth Quarry Co., Limited	Vinemount	do
Wilson, G. S.	Marion	Sandstone.

GRANITE AND TRAP QUARRIES.

Name of Owner, Firm or Company.	Location.	Kind of Stone.
Bannerman & Horne	Ignace and Butler	Granite Blocks.
Bruce Mines Trap Rock Co., Limited	Bruce Mines	Trap.
Gordon & Bruce	Lyndhurst, R.R. No. 2	Granite.
Gordon Granite Co., D. J.	Gananoque	Granite Blocks and Monuments.
Granite, Crushed and Dimension, Limited	Washago	Granite Road Metal.
Grant & Son, Jno.	Actinolite	Granite Blocks.
Ontario Rock Co., Limited	Preneveau	Trap.
Oscar Daniels Company	St. Joseph Island	Trap.
Street & O'Brien	Gananoque	Granite Paving Sets.

QUARTZ QUARRIES.

Name of Owner, Firm or Company.	Location.	P.O. Address of Manager, etc.
Canadian Copper Company, Limited	Dill	42 Exchange Place, New York.
Canada Pebble Company, Limited	Jackfish	Jackfish.
Dominion Mines and Quarries, Limited	Port Neebish	Sault Ste. Marie, Mich.
McPhail & Wright Construction Co., Limited	Mile 21, A. C. Ry.	Sault Ste. Marie.
Mond Nickel Company, Limited	Neelon tp.	Coniston.
Willmott & Company	Killarney	104 Lumsden Bldg., Toronto.

Arsenic

Statistics of production of arsenic have already been given in connection with the operation of the silver refineries. Shipments during the year amounted to 4,321,180 lbs., worth $200,103. By far the larger part of the product was the refined oxide, or white arsenic. About 90 tons of crude oxide were sold, and also over 11 tons of arsenic metal.

The entire output of the year was obtained in the refining of the silver ores of the Cobalt area, but there are other sources of supply in Ontario, if prices and demand should warrant their being called upon. Among these is the county of Hastings, where extensive deposits of mispickel exist, some of it auriferous. The gold-arsenic ores of this locality furnished large quantities of white arsenic when the mines were in operation a number of years ago. Arsenical ores are also found in the neighbourhood of lake Timagami and elsewhere.

Corundum

The only producer is Manufacturers Corundum Company, Limited, whose mines and works are at Burgess Mines in the county of Hastings. The quantity of grain corundum marketed in 1916 was 131,810 pounds, valued at $8,763.

Corundum is used as an abrasive, but of late years it has met with active competition from various artificial products, intended for the same purpose, made chiefly in the electric furnace.

Feldspar

The quantity of feldspar shipped from the several properties operated last year was 12,965 tons, as compared with 12,619 tons in 1915. The principal producer was the Kingston Feldspar and Mining Company, Limited, whose property in the township of Bedford was taken over in June by Feldspars, Limited. It was in operation throughout the whole of the year. Other producers were the Canada Feldspar Corporation, Limited, near Verona; S. W. Hall, Macaulay township, Muskoka, and J. M. Stoness and Son, Crow Lake.

Practically the entire production is exported to Ohio and New Jersey, for use in the manufacture of pottery and enamelled ware. There has been considerable inquiry for workable feldspar properties high in potash, stimulated by the efforts that have been and continue to be made to put this constituent in form suitable for fertilizing purposes. Other uses, such as in making detergent products, call for limited quantities.

Though a common mineral in rock structures, it is only when it occurs in masses free or nearly free from quartz and other impurities, that feldspar can be worked. It will be seen from the description given by Dr. W. G. Miller and C. W. Knight in another part of this Report, it was in a feldspar quarry near Maberley that the radium-carrying mineral euxenite was found.

Following are the companies or individuals engaged in the production of feldspar:—

FELDSPAR PRODUCERS, 1916.

Name.	Location of Deposit.	P.O. Address.
Canada Feldspar Corporation, Limited	near Verona	168 Madison Ave., Toronto.
Feldspars Limited	Bedford tp.	Hartington, R.R. No. 1.
S. W. Hall	Macaulay tp.	118 Barton Ave., Toronto.
McDonald Feldspar Co., Limited	near Verona	58 King St. W., Toronto.
Ojaipee Silica-Feldspar Mines	Conger tp.	375 Spadina Ave., Toronto.
J. M. Stoness and Sons	Crow Lake	Westport.

Idle in 1916.

Fluorspar

The increased demand for fluorspar has come largely from steelmakers. It is used chiefly as a flux, but also in the manufacture of hydro-fluoric acid, and in certain metallurgical operations. A newer use is in the recovery of potash from feldspar and from Portland cement clinker.

The last previously reported production of fluorspar was in 1911, when $200 worth was marketed. In 1916 the shipments amounted to 1,283 tons, valued at $10,116, the price averaging nearly $8 per ton. It all came from the vicinity of Madoc. During the year the price rose rapidly, and towards the close $15 per ton was being paid. Early in 1917 still higher prices obtained. Employees to the number of 31 received $8,449 in wages.

FLUORSPAR OPERATORS.

Name.	Location.	Address.
Cross & Wellington	Lot 11, Con. XIII, Huntingdon	Madoc.
C. R. Ross	Lot 2, Con. IV, Madoc	Madoc.
Wellington & Munro	Lot 13, Con. XII, Huntingdon	Madoc.

Graphite

There were three producing properties in 1916, those of the National Graphite Company, Limited, Monteagle township; Black Donald Graphite Company, Limited, Brougham township, and The Globe Graphite Mining and Refining Company, Limited, Port Elmsley. The total quantity of refined graphite marketed by these concerns was 3,446 tons, valued at $249,586, a considerable advance over the production of 1915, namely, 2,534 tons worth $115,274. The number of employees, in the mills and underground, was 227, to whom were paid wages amounting to $133,960. All three companies mentioned have works for refining the graphite.

As is well known, graphite is used as a lubricant, for making lead pencils, as facing for foundry purposes, stove polish, etc. The flake variety, specially adapted for the manufacture of crucibles, brings the highest price.

Graphite is one of the minerals in which nature is emulated by man. The artificial variety, made in the electric furnace from powdered coke, is in good demand especially for electrodes for lighting and furnace work.

The graphite producers are as follows:—

GRAPHITE PRODUCERS, 1916.

Company.	Location of Mine.	P.O. Address.
Black Donald Graphite Co., Limited	Brougham tp.	Calabogie.
National Graphite, Limited	Monteagle tp.	402 Lumsden Building, Toronto.
The Globe Graphite Mining and Refining Co., Limited	Port Elmsley	410 Dillaye Building, Syracuse, N.Y., U.S.A.
J. G. Allan	near Denbigh	27 Hillcrest Avenue, Hamilton.
Tonkinedo Pont Graphite Co., Limited	Maynooth†	309 Church St., Phoenixville, Pa., U.S.A.

Idle in 1916. † Refinery at Wilberforce.

Gypsum

The output comes from the valley of the Grand river. Two companies, the Alabastine Company, with mines at Caledonia and a manufacturing plant at Paris, and the Crown Gypsum Company, with mines and works at Lythmore, operated during the year. These companies formed an amalgamation under the name of The Ontario Gypsum Company, Limited, to take effect 1st January, 1917. Production was reduced as compared with 1915, there being a total output of crude of 39,393 tons, as compared with 85,144 the previous year. There were shipped in the

form of crushed crude 10,718 tons, ground crude 2,681 tons, and calcined crude 5,113 tons. The quantity of gypsum in the manufactured products, such as wall plaster, alabastine, etc., was 17,823 tons. There is a certain demand for unmanufactured gypsum as a fertilizer, and for use in Portland cement to regulate the rate of setting.

The large deposits of gypsum reported from the banks of several of the rivers running into James Bay are as yet too remote from transportation facilities and markets to be worked.

GYPSUM MINES, 1916.

Company.	Location of Mine.	P.O. Address.
The Alabastine Co. of Paris, Ltd.	Caledonia	Paris.
Crown Gypsum Company, Ltd.	Lythmore	Lythmore.

Iron Pyrites

An upward trend in pyrite shipments, beginning in 1913, has continued steadily to date. The 1915 production was more than double that for 1913, while the 1916 output marketed shows an increase in tonnage over 1915 of nearly 21 per cent., and in value over 33 per cent., the output for the year being 175,593 tons, worth $471,807. A new shipper and the largest in 1916 was the Goudreau mine of the Madoe Mining Company. This mine is situated on the Algoma Central railway. Another new shipper was T. B. Caldwell, of Lanark, who opened up a property near Flower station on the Kingston and Pembroke railway. The restricted production from Northpines near Superior Junction on the National Transcontinental railway was due to a complete overhauling of the mine equipment preparatory to beginning production on a greatly increased scale.

Sulphur is in great demand owing to the stoppage of European supplies. Several large chemical companies in the United States who use sulphur ore are seeking to purchase properties in this Province. The Nichols Chemical Company, at Sulphide, and the Grasselli Chemical Company, of Hamilton, are purchasers of pyrite ore for treatment in their acid plants.

During the year 117 men were employed who received wages amounting to $111,368.

IRON PYRITE SHIPPERS, 1916.

Name of Owner, Firm or Company.	Location or Name of Mine.	P.O. Address of Manager, etc.
Algoma Steel Corporation, Limited	Helen	Sault Ste. Marie.
T. B. Caldwell	Clyde Lake Siding	Lanark.
Canadian Sulphur Ore Company, Limited	Queensboro	404 Lumsden Bldg., Toronto.
Madoe Mining Company	Goudreau	Goudreau.
Nichols Chemical Company, Limited	Sulphide	Sulphide.
Northern Pyrites Company, Limited	Vermilion Lake ..	Northpines.
John T. O'Connor	Timagami	Buffalo, N.Y.

Mica

Rough-cobbed mica mined and raised in 1916 totalled 143¼ tons, valued at $28,030. The bulk of this production was from the Sydenham (Lacey) mine of the Loughborough Mining Company. Trimmed mica worth $27,077 was produced, the quantity being 123 tons. In all 266 tons were obtained worth $55,107, an increase over 1915 of 71 tons and $21,917.

The following properties were operated during 1916:—

MICA PRODUCERS, 1916.

Name of Owner or Company.	Location or Name of Mine.	P.O. Address of Manager, etc.
Dominion Improvement & Development Co.	North Burgess tp.	Perth.
Kent Bros. and J. M. Stoness	Bedford tp.	Kingston.
Loughborough Mining Co., Ltd.	Lacey mine	Sydenham.
S. H. Orser Mica Co.	North Burgess tp.	Perth.
Sydenham Mica and Phosphate Mining Co., Limited	Sydenham	Sydenham.

Natural Gas

In 1916 the production of natural gas was 17,953,396 M. cubic feet worth $2,101,199, an increase of 18 per cent. in output, but a decrease of over 8 per cent. in value, in a year when practically every other commodity advanced in price. The explanation may be found in a decreased domestic and an increased industrial consumption, with low prices to large consumers, by no means an ideal situation from the viewpoint of conservation. Assuming the heat value of 24,000 cubic feet of natural gas to be equivalent to a ton of coal, the price of the latter would have to be as low as $2.64 per ton delivered to compete with natural gas at 11 cents per thousand, which is the cost to large manufacturers in Kent county. Gas fields cannot live forever, and it is only by drilling new wells annually that the supply is maintained. Legislation to control the price of natural gas, or to restrict its use for industrial purposes, would appear necessary if the supply is to be conserved for domestic use.

At the end of the year there were 1,802 producing wells, an increase of 68 over 1915. The industry employed 653 men whose wages amounted to $101,039. Some 2,233 miles of pipe line were reported. This mileage, however, does not include distributing systems in towns and cities.

NATURAL GAS STATISTICS, 1916.

Gas wells drilled in year:		
Productive	135	
Non productive	38	
		173
Producing wells at end of year		1,802
Miles of gas pipe		2,233
Workmen employed		653
Wages for labour		$101,039
Gas production:		
Quantity (million cu. ft.)		17,953
Value		$2,101,199

The list of natural gas producers for 1916 was as follows:

NATURAL GAS PRODUCERS, 1916.

Name of Person or Company.	Producing Wells, Dec. 31, 1916.	Township.	P.O. Address of Manager, etc.
†Aikens, Beck and Lalor	18	S. Cayuga, Dunn	Dunnville.
Alabastine Co., Paris, Limited	4	Seneca	Paris.
Aldrich Gas & Oil Co., Limited	9	Rainham	Hamilton.
Azoff Natural Gas Co., Limited	1	N. Cayuga	Canfield.
Barnard-Argue-Roth-Stearns Oil & Gas Co., Limited	1	E. Tilbury	401 Iroquois Building, Buffalo, N.Y.
Beaver Oil & Gas Co., Limited	23	Romney & E. Tilbury	Buffalo, N.Y.
Bertie Natural Gas Co., Limited	8	Bertie	Ridgeway.
Canadian Gas Co., Limited	37	Romney, Tilbury E.	1426 Dime Bank Bldg., Detroit, Mich.
Canfield Natural Gas Co., Limited	3	N. Cayuga	Canfield.
Cheapside Natural Gas Co., Ltd.	..		Cheapside.
Chippawa Development Co., Ltd.	8	Willoughby	Chippawa.
Chippawa Oil & Gas Co., Limited	37	Caistor, Canboro and Cayuga	Tavistock.
Coleman, J. A.	4	Wainfleet	Wellandport.
Commonwealth Oil & Gas Co., Ltd.	2	Onondaga	240 King St. E., Hamilton.
Crystal Oil & Gas Co., Ltd.	1	Onondaga	Paris.
Douskin, D.	1	Brantford	Cainsville.
Darling Road Co-operative Gas Co.	6	Canboro, N. Cayuga	Darling Road.
Deagle, John	1	Onondaga	Middleport.
Dominion Natural Gas Co., Ltd.	714	Lincoln, Wentworth, Elgin, Norfolk and Haldimand (counties)	842 Marine Bank Bldg., Buffalo, N.Y.
Douglas, W. A.	1	Oneida	Caledonia.
Dunn Natural Gas Co., Limited	19	Dunn	Dunnville.
Duxbury, Wellington	1	Walpole	Hagersville.
East Side Gas Co., Limited	7	Sherbrooke	Lowbanks.
Emerson, Troughton & Laidlaw	4	Canboro	Attercliffe Station.
Empire Limestone Co., Limited	4	Humberstone	Hudson & 4th Streets, Buffalo, N.Y.
Fairbank Estate, J. H.	1	Enniskillen	Petrolia.
Fisherville Gas Co., No. 1	2	Rainham	Fisherville.
Fletcher, J. I.	1	Binbrook	Hannon.
Glenwood Natural Gas Co., Ltd.	60	Raleigh, Romney and Tilbury E.	Buffalo, N.Y.
Hager, Ham	1	Onondaga	Middleport.
Hamilton Gas & Oil Co., Limited	..		Hamilton.
Helka, Fred	1	Rainham	Fisherville.
Hendee Natural Gas Co.	6	S. Cayuga	Cayuga.
Holmes Gas Co., Limited	23	Rainham and Walpole	Buffalo, N.Y.
†Home Natural Gas Co.	4	Oneida	Hamilton.
Hoover, D. E.	1	Rainham	Selkirk.
†Hoover, D. E., A. E., and Menno.	8	Rainham	Selkirk.
Hoover, James E.	..		Selkirk.
†Hyde & Snively	..	S Cayuga	Dunnville.
Industrial Natural Gas Co., Ltd.	38	Bertie, Crowland and Humberstone	Port Colborne.

NATURAL GAS PRODUCERS, 1916.—*Continued.*

Name of Person or Company.	Producing Wells, Dec. 31, 1916.	Township.	P.O. Address of Manager, etc.
Jones, James S.	3	Port Maitland (vill.)	Port Maitland.
Jones, Nelson	2	Canboro, Moulton	Attercliffe Station.
Kindy Gas Co., Limited	7	Rainham	Cayuga.
Kindy & Sons, D.	7	Rainham	Selkirk.
Kittinger Gas Co., Limited	5	Moulton	118 E. Eagle St., Buffalo, N.Y.
†Kohler & Aikens	21	Canboro	Dunnville.
Lalor, F. R.	5	Moulton	Dunnville.
Lalor & Vokes	11	Walpole	Dunnville.
Lamb, Alfred	13	Walpole	Selkirk.
†Lamb, Walter B.	11	Walpole	Nanticoke.
Lawson, J. J.	..		Low Banks.
Liesinger-Lembke Co.	1	Humberstone	Buffalo, N.Y.
Marshall Lime & Cement Works, Jas.	15	Glanford and Seneca	Hamilton.
Martin, Edward	3	Port Maitland (vill.)	Dunnville.
Mayer, J. E.	..		Buffalo, N.Y.
Medina Natural Gas Co., Limited	23	Bayham	Chatham.
Midfield Natural Gas Co., Limited	7	N. Cayuga	32 Stinson St., Hamilton.
Mickle, Geo. T., & McKechnie, S.	4	Canboro	Ridgetown.
Moore & Ricker	..		Canboro.
Miner & Melinbecker	1	Humberstone	Humberstone.
†Moote, Melick & Lymburner	10	Canboro	Canboro.
Nanticoke Natural Gas Co., Ltd.	2	Walpole	Nanticoke.
National Gas Co., Limited	72	Rainham, Seneca	503 Bank of Hamilton Bldg., Hamilton.
Niagara Natural Gas & Fuel Co., Ltd.	4	Humberstone	Fenwick.
North Shore Gas Co., Limited	10	Rainham	Hamilton.
Northwestern Gas Co., Limited	4	Brant (county)	13 Scott Block, Erie, Pa.
Oil Springs Oil & Gas Co., Ltd.	6	Enniskillen	Oil Springs.
Onondaga Oil & Gas Co., Ltd.	6	Onondaga	Brantford.
Oxford Oil & Gas Co., Limited	..		Brantford.
†Patterson, T. H.	17	Seneca	Blackheath.
Port Colborne-Welland Natural Gas & Oil Co., Limited	24	Seneca, Oneida, Onondaga	Port Colborne.
Preston Natural Gas & Oil Co., Ltd.	..		Guelph.
Provincial Natural Gas & Fuel Co. of Ontario, Limited	222	Welland (county)	Niagara Falls.
†Regal Natural Gas Co.	3	Hagersville (village)	Hagersville.
Relief Gas Co., Limited	25	Gainsboro, Wainfleet and Pelham	St. Catharines.
Robinson Road Gas Co.	4	Canboro and Moulton	Dunnville.
Rollston & Bennett	..		Dunnville.
Rose, M. E.	4	Seneca	Blackheath.
Snively, F. L., Gas Co., Limited	..		Dunnville.
Spatham, Andrew	..		Blackheath.
Springvale Oil & Gas Co., Ltd.	3	Walpole	Hagersville.
Standard Natural Gas Co., Ltd.	33	Onondaga	Buffalo, N.Y.
Sterling Gas Co., Limited	61	Humberstone, Wainfleet and Moulton	Port Colborne.

NATURAL GAS PRODUCERS, 1916.—*Continued.*

Name of Person or Company.	Producing Wells, Dec. 31, 1916.	Township.	P.O. Address of Manager, etc.
Stevensville Gas & Fuel Co.	3	Bertie	Stevensville.
Sundy Gas Well Co.	3	Canboro	Dunnville.
Telephone City Oil & Gas Co. Ltd.	4	Onondaga	Hamilton.
Union Natural Gas Co. of Canada, Limited	125	Kent and Lambton (counties)	Niagara Falls.
*United Gas Companies, Limited..	50	Wainfleet, Moulton and Gainsboro	St. Catharines.
Vansickle, A. W.	2	Onondaga	Cainsville.
Vacuum Gas & Oil Co., Limited..	2	Middleton	292 Rushton Road, Toronto.
Wainfleet & Moulton Gas Co.	3	Middleton	Lowbanks.
Welland County Lime Works Co., Limited	30	Wainfleet	Port Colborne.
Wedrick, M.	3	Walpole	Nanticoke.
Wyley, W.	..	....	Glanford.

*These subsidiary companies are controlled from the head office of the Dominion Natural Gas Company, Limited, 842 Marine Bank Building, Buffalo, N.Y.

†Purchased by the Dominion Natural Gas Company during the year 1916.

During 1916 there were 173 new wells drilled, of which 38 were dry and 135 producers.

Companies operating 50 or more producing wells are enumerated hereunder:—

Company.	Producing Wells, Dec. 31, 1916.	Miles of Pipe Line.
Dominion Natural Gas Co., Limited	714	641
Provincial Natural Gas & Fuel Co., Limited	222	284
Union Natural Gas & Fuel Co. of Ontario, Limited...	125	137
National Gas Co., Limited	72	50
Sterling Gas Co., Limited	61	150
Glenwood Natural Gas Co., Limited	60	54
United Gas Companies, Limited	50	79

The Dominion Natural Gas Company has furnished information in regard to its operations, a synopsis of which follows:—

Wells are located in 21 townships or municipalities, of which Walpole township has 165, Canboro 94, Rainham 92, South Cayuga 81, Woodhouse 18, Seneca 15, Binbrook 12, and lesser numbers in the other municipalities.

The Selkirk field in Norfolk and Haldimand counties, which includes wells in the first five townships above mentioned, shows an average rock pressure of 154 pounds, with a low average of 46 in Moulton township and a high of 210 in Woodhouse. This field shows a low average open flow production of 13,000 cubic feet in Moulton township and high average of 62,000 in North Cayuga.

The Simcoe field in Norfolk county shows 322 pounds average rock pressure, with 210 pounds (low) in Woodhouse and 198 pounds (high) in South Walsingham. A low average production of 15,000 cubic feet is recorded for Port Rowan and high average of 107,000 for Windham.

Wentworth, Lincoln and Haldimand counties comprise the Blackheath field, with average rock pressure of 134 pounds, low average production of 33,000 cubic feet in Caistor township and high average of 66,000 cubic feet in Glanford township.

The Vienna field comprises Bayham township in Elgin county and Houghton in Norfolk. The average pressure in the former is 298 pounds, and production 115,000 cubic feet. In the latter the figures are 500 and 93,000 respectively.

During the year this company acquired by purchase 140 wells owned by nine different producers. The following companies were amalgamated with the Dominion: Waines and Root, Producers' Natural Gas Co., Enterprise Gas Co., Norfolk Gas Co. and Port Rowan Gas Co.

Following is a list of companies which pipe natural gas from the wells to points of consumption or who distribute it there:—

PIPE LINE COMPANIES OR DISTRIBUTORS ONLY OF NATURAL GAS.

Brantford Gas Company, Limited.
Central Pipe Line Company, Limited, Chatham.
Chatham Gas Company, Limited.
Independent Natural Gas Company, Dunnville.
Ingersoll Gas Light Company, Limited.
Lake Shore Natural Gas Company.
Manufacturers' Natural Gas Company, Limited, Buffalo, N.Y.
Nelles Corners Gas Company.
Northern Pipe Line Company, Limited, Buffalo, N.Y.
Petrolia Utilities Company, Limited.
Rose Hill Natural Gas Company.
Sarnia Gas & Electric Light Company, Limited.
Southern Ontario Gas Company, Limited, St. Thomas.
Thorold Gas Company, St. Catharines.
Tilbury Town Gas Company.
Town of Leamington.
United Gas & Fuel Co. of Hamilton, Limited.
Wellandport Natural Gas Company, Wellandport.
Windsor Gas Company, Limited.
Woodstock Gas Light Company, Limited.

Details of Natural Gas Industry

G. R. Mickle, Mine Assessor, who has supervision over the inspection of natural gas wells and the collection of the revenue from natural gas, furnishes the following notes respecting the industry. It will be noted that Mr. Mickle's figures of production compiled from returns made to him for purposes of the Mining Tax Act, do not greatly differ from those procured by the Bureau from the producers.

The amount of natural gas produced in the Province in 1916 was 17,929.1 million cubic feet, an increase of about 18 per cent. over the output of the previous year. This is due almost entirely to greater production from the Kent field. The distribution of the output is as follows:—

	Million Cu. Ft.		Per cent.
1. Welland-Haldimand, etc.	3,769.5	or	21.0
2. Kent	13,752.5	"	76.8
3. Elgin	351.9	"	2.0
4. Lambton	55.2	"	0.2
Total	17,929.1	"	100.

This includes an estimated production from a number of small operators who give no returns.

The first of these fields comprises a number of scattered productive areas extending through the southerly parts of the counties of Welland, Haldimand, Norfolk, Brant, Wentworth. Many of these productive areas are nearly exhausted, and gas from Kent has been

brought into towns which were formerly supplied from adjacent territory. These put a heavy burden on the Kent gas field, and new discoveries of important sources are urgently needed. The desirability of fresh sources of gas is accentuated by the high price of coal. The amount given above as the production is equivalent to about 746,000 tons of coal, reckoning one ton of coal equal to 21,000 cu. ft. of natural gas; this is probably a rough estimate of the relative heating value of coal.

The total yield of gas from the Welland-Haldimand field to the end of 1916 is 57,672 million feet, including an estimated production during the early life of the field.

From Kent the production up to the same time amounts to 65,801 million cu. ft., or about 2,000 million cu. ft. from each square mile in this field; at 10 cents per thousand for the gas in the field, this is an output of $200,000 per square mile, with still a great deal more to come. The outstanding feature of the Kent field is its extraordinary productiveness. The production given above is slightly more than the minimum possible yield calculated in 1910 from noting the yield up to that time and the drop in pressure (p. 150, Vol. XIX, Report Bureau of Mines), showing that, as the pressure drops, gas must find its way in from under the bed of the lake.

The total output of the Elgin field from its first production in 1911 is now 2,265.1 million cu. ft. It seems probable that extensions of this will be found, or small similar areas.

The Lambton field at Oil Springs has produced 626 million cu. ft. The wells in this field do not appear to have much life ahead of them.

While no new important discoveries were made in 1916, there was an interesting and possibly important result obtained in the spring of 1917 in Dover township, Kent county, near Lake St. Clair. Gas was found apparently in important quantities at a depth of 3,000 ft. approximately in the Trenton. The discovery was made by the Union Natural Gas Company at a point about ten miles distant from the Kent gas field.

The Bureau of Mines maintains three gas and oil inspectors in the producing areas for the purpose of enforcing the regulations respecting the plugging of abandoned wells, wasting of gas, etc. These are John Scott, Petrolea; A. E. Near, Gas Line, and J. W. Beno, Chatham. Mr. Scott has jurisdiction chiefly over the oil and gas wells in Lambton county and neighbourhood, Mr. Near over the Welland-Haldimand field, and Mr. Beno over the Tilbury area.

The following extracts are from Mr. Near's report:—

During the year considerable drilling has been done, especially by the two largest companies operating in this district—The Dominion Natural Gas Company of Hamilton, and the Provincial Natural Gas and Fuel Company of Niagara Falls, Ontario.

The Dominion Natural Gas Company drilled, during the year 1916, 87 wells, of which 68 were producing wells and 19 non-producing. It also purchased 164 wells, and abandoned 15, leaving it at the close of the year with 737 producing wells. The total open flow production from the company's own wells was 8,176,000 cu. ft., which, together with 1,166,399,000 cu. ft. purchased, enabled it to supply upwards of 34,498 customers. This company also receives a considerable supply of gas from the Southern Ontario Gas Co., Limited, the product from the Tilbury gas field, which is impregnated with sulphur. This gas is now, however, being purified before being used for domestic purposes. Gas from the Tilbury field is also supplied to Brantford, Paris, Galt and other places along the line.

The Provincial Natural Gas and Fuel Company of Niagara Falls, Ontario, during the past year drilled 14 wells in the Welland county gas field, of which only 5 were producing wells, making a total of 222 producing wells owned by this company. The total product of gas from these wells was 664,810,000 cu. ft., with which, and 11,346,000 cu. ft. purchased, it gave a fairly satisfactory supply of gas to its many customers in the city of Niagara Falls, the towns of Welland and Bridgeburg, and the villages of Fort Erie, Stevensville, Ridgeway and Crystal Beach.

During the year 1916 a new company was organized under the style and name of "Vacuum Gas and Oil Co., Limited," 608 Lumsden Building, Toronto; E. P. Rowe, General Manager. It has drilled a number of wells in the township of Dereham, Oxford county.

A second company was formed under the name of American Gas, Gasoline and Oil Manufacturing Company, Limited, of New York; Eugene F. Deiner, of Dunnville, president. This company has a considerable territory of lands under lease in the townships of Moulton and Canboro, Haldimand county.

Mr. Beno reports that 45 new gas wells were drilled and 47 miles of new gas mains laid down in the Kent county field in 1916, the field comprising the town-

ships of Romney, Raleigh and Tilbury East. The total number of gas wells being operated was 259, and the estimated length of all the gas mains now existing is 502 miles, the size of the mains ranging from 3 to 12 inches in diameter. If the distributing systems of the cities, towns and villages, and all the rural lines of 2 inches and under in diameter were included, the aggregate length of the gas lines would be 1,000 miles or more. Mr. Beno adds that the wells in the south-western side of the field are weakening rapidly, and will probably not last long, if they continue to be drawn upon as heavily as at present.

Petroleum

The yield of petroleum in 1916, namely, 6,890,681 imperial gallons* (196,876 barrels) shows a decrease of 8 per cent. as compared with that of 1915. By districts the production for the two years was as follows, in gallons:—

——	1915	1916	Gain.	Loss.
Lambton	5,647,894	4,977,286	....	670,608
Bothwell	1,168,829	1,184,968	16,139	....
Dutton	189,046	99,814	....	89,232
Tilbury	445,957	570,391	124,434	....
Onondaga	52,160	56,612	4,452	....
Belle River	1,592	1,610	18	....
Total	7,505,478	6,890,681	145,043	759,840

Commenting on these figures, Charles Jenkins, of Petrolia, a veteran operator, says:—

Lambton county shows a greater loss than the entire Province. This can be accounted for by surface conditions of pumping. The soil is very heavy clay land, and in the months of April and May and well on into June the wet spring checked very materially the team work necessary to keep the pumps in proper working condition. Again, in July and August the heat and drought were extreme, and the jerker line systems, by virtue of expansion, were continually breaking, requiring repair and delaying pumping. There was thus, therefore, a known loss in production. The Dutton statement does not show the actual loss, if any. The 1915 figures were swelled by 1914 oil carried over and not delivered till 1915.

If Lambton figures are taken for four years and averaged, the production is 152,000 barrels per annum. Without special setbacks in surface working as in 1916, I think the 1915 record would have been nearly attained.

Some prospecting work goes on. I understand some attempts to explore the Trenton vicinity, Lake Erie, are going on. At Thamesville a sustained effort is being made to develop a permanent producing centre, but the territory is shallow.

The price of crude was advanced 10 cents per barrel (35 gallons) on January 3, making it $1.83; two additional gains of 5 cents in January, one in February, another of 5 cents and one of 10 cents in March brought the price to $2.03; by 11th August it had declined to $1.83, at which figure it remained until 18th November, when it rose to $1.88, and closed 31st December at $1.98. The average price during the year for Petrolea crude was $1.91 7-13 per barrel, and for Oil Springs crude $1.99 7-13.

*Figures kindly supplied by Samuel Pollard, Supervisor of Crude Oil Bounties, Petrolia. The bounty of 1½ cents per gallon on crude oil is paid by the Dominion Government.

J. Scott, inspector of oil and gas wells, reports the following figures regarding the wells of the oil district as follows:—

OIL WELLS IN LAMBTON DISTRICT.

Field.	Pumped.	Baled.	Not operated.	Abandoned.	Total.
Enniskillen-Moore	2,347	479	940	344	4,110
Sarnia-Plympton	161	....	73	7	241
Oil Springs	1,462	....	89	....	1,551
Dutton	192	....	15	....	207
Euphemia-Dawn	91	....	50	50	191
Bothwell	195	....	16	1	212
Thamesville	20	....	36	3	59
Brooke	10	....	....	1	11
Indian Reserve	....	....	....	....	11
Total	4,481	479	1,230	406	6,596

Inspector Beno reports that in Essex and Kent counties 51 oil wells were in operation in 1916, and 38 were standing idle. Ten new wells were drilled during the year.

Salt

Salt marketed in 1916 exceeded that in 1915 both in quantity and value, the figures for 1916 being 128,935 tons worth $700,515, as compared with 116,618 tons valued at $585,022 in 1915. The output was restricted owing to scarcity of labour. One well at Wingham was lost in January, and the plant not operated until a new well was completed in October. Wages amounting to $208,673 were paid 238 employees. Of the total tonnage marketed 56,325 tons were coarse or land salt, 30,291 tons fine and 30,640 tons dairy. The chemical plant of the Canadian Salt Company at Sandwich, where caustic soda and bleaching powder are produced, used brine equivalent to 11,679 tons of salt.

The following were salt producers in 1916:—

SALT COMPANIES, 1916.

Name of Owner, Firm or Company.	Location of Wells or Works.	P.O. Address of Manager, etc.
Alex Young Estate	Wingham	Wingham.
The Canadian Salt Company, Limited	Windsor Sandwich	Windsor.
The Dominion Salt Company, Limited	Sarnia	Sarnia.
The Earlton Salt Works Company, Limited	South of Egremont Road, Warwick tp.	Hyde Park.
Exeter Salt Works Company, Limited	Exeter	Exeter.
Ontario People's Salt and Soda Co., Limited	Kincardine	Kincardine.
Western Canada Flour Mills Company, Limited	Goderich	Goderich.
The Western Salt Company, Limited	Mooretown and Courtright	Courtright.

Talc

Shipments of talc in 1916 exceeded those of the preceding year both in quantity and value. The figures for 1915 were 1,720 tons of crude and 9,285 tons of ground, as compared with 3,665 and 8,145 tons, respectively, in 1916. The total valuation of both crude and ground for 1916 was $111,189, an advance of $26,161 over the preceding year. All the ground talc was produced at the Madoc mill of G. H. Gillespie and Company, which treates 30 to 35 tons of crude daily. Eldorite, Limited, closed down the Eldorado plant on September 1, 1916. The bulk of the crude came from the Henderson mine near Madoc, operated by Cross and Wellington, 1,755 tons being shipped to the United States and 8,136 tons delivered to the Gillespie mill. The Anglo-American Talc Corporation are erecting a mill on their property which adjoins the Henderson mine. Ground talc has a variety of uses such as talcum powder and as filler for cotton, paper, rubber, soap, etc. The industry employed 60 men whose wages amounted to $32,131.

The operators are as follows:—

TALC OPERATORS, 1916.

Firm or Company.	Location of Mine or Works.	Address of Manager, etc.
Anglo-American Talc Corporation, Ltd.	Huntingdon tp. (Connolly mine) ..	Madoc.
Cross and Wellington	Huntingdon tp. (Henderson mine)	Madoc.
Eldorite, Limited	Eldorado	Eldorado.
Gillespie, G. H., & Co.	Madoc	Madoc.

Mining Divisions

For purposes of administration under the Mining Act, the mineral regions of the Province are subdivided into Mining Divisions. The officer in charge of a Division is called a Mining Recorder, and all mining claims on Crown lands staked out in the Division must be filed with him. He has power to settle disputes between mining licensees, there being a right of appeal to the Mining Commissioner, whose decisions in important matters are subject to review by the courts of law. The list of Divisions is as follows, with the name and headquarters of the several Recorders, and figures representing the business done by each during 1916. Mining claims staked out on lands not included within the limits of a Mining Division, as for instance, in eastern Ontario and in the Rainy River area, are recorded in the Department of Lands, Forests and Mines, Toronto, which also collects all the mining revenue that does not pass through the hands of the Mining Recorders.

MINING DIVISIONS, 1916.

Mining Division.	Name and P.O. Address of Recorder.	Receipts, 1916. Purchase price.	Permits.	Miner's licenses.	Recording fees.	Total.
		$ c.	$ c.	$ c.	$ c.	$ c.
Sault Ste. Marie	W. N. Miller, Slt. Ste. Marie	532 15	......	656 00	1,080 00	2,268 15
Sudbury	C. A. Campbell, Sudbury	11,244 07	300 00	2,728 00	6,669 75	20,941 82
Porcupine	G. H. Gauthier, S. Porcupine	8,861 41	330 00	2,890 00	4,841 25	16,922 66
Larder Lake	J. A. Hough, Matheson	5,929 07	......	2,252 50	11,817 50	19,999 07
Port Arthur	J. W. Morgan, Port Arthur	3,942 38	20 00	2,113 00	5,593 25	11,668 63
Parry Sound	H. F. McQuire, Parry Sound	....	......	187 00	178 00	365 00
Gowganda / Montreal River	A. J. Browning, Elk Lake	4,052 03	100 00	726 25	1,310 00	6,188 28
Temiskaming / Coleman	N. J. McAulay, Haileybury	3,532 50	60 00	6,114 00	3,865 00	13,571 50
Kenora	W. L. Spry, Kenora	1,086 25	.....	632 00	656 75	2,375 00
Kowkash	M. R. Morgan, Tashota	....	60 00	124 00	1,088 65	1,272 65
Total		39,179 86	870 00	18,422 75	37,100 15	95,572 76

The promising discoveries of gold made in the neighbourhood of Kowkash, on the National Transcontinental railway, made it desirable to establish an office in the field for the recording of claims and the general convenience of prospectors. A tract containing about 17,000 square miles was accordingly detached from the Mining Division of Port Arthur and set apart as the Kowkash Mining Division, with head office at Tashota on the Transcontinental railway. Mark R. Morgan, formerly assistant in the Recorder's office at Port Arthur, was appointed Recorder, 26th May, 1916.

The limits of the Kowkash Division are as follows: So much of the territory as is situated within the Nipigon Forest Reserve remaining subject to the Forest Reserves Act and regulations:—

Commencing at the southeast angle of the township of Henderson, being a point in the boundary line between the districts of Algoma and Thunder Bay 74 chains 48 links north of the 93rd mile post on said District line; thence west astronomically along the south boundaries of the townships of Henderson, Selwyn, Barlow, Goodwin, Chipman and Raynar 54 miles more or less to the southwest angle of the last-mentioned township; thence continuing west astronomically 67 miles more or less to a point on the shore of Lake Nipigon at or near Humboldt Bay; thence in a general direction northwesterly, westerly and southwesterly following the shore line of Lake Nipigon in all its windings to the Wabinosh river, where it enters Wabinosh bay of said Lake Nipigon; thence northwesterly following the south shores of Wabinosh Lake, Waweig or Round Lake, Sucker Lake, Valley Lake, Clear Lake, Tunnel Lake and connecting streams to the west boundary of the Nipigon Forest Reserve; thence north astronomically along said west boundary of the Nipigon Forest Reserve and continuing north astronomically 85 miles more or less to the south shore of the Albany river; thence in a general course easterly along the south shore of said Albany river to its intersection with the boundary between the Districts of Thunder Bay and Algoma; thence south astronomically along the said District boundary line 110 miles more or less to the point of commencement.

Reports from Mining Recorders

The several Recorders, in reporting on the business of their offices at the close of the year, remark on matters of interest to the mining community in their respective Divisions. From these notes the following extracts are made:—

Sault Ste. Marie.—There was some activity in the sulphide ores in township 19, and in copper back of Thessalon. Claims recorded 41, cancelled 21.

Sudbury.—There was no new field opened up, and although business was fairly good, it was confined for the most part to West Shining Tree and the nickel range. It may be interesting to note that the Longyear people made an extensive find of nickel in the township of Falconbridge. The claims were originally staked as working permits, owing to the fact that there was not sufficient rock on the properties to make a discovery, so the claims were really staked with only a map of the nickel range as a guide. However, they went to work with diamond drills and turned up an extensive deposit of low grade nickel ore. Claims recorded 464, licenses issued 225, licenses renewed 316.

Porcupine.—During the year nearly all of the established mines have increased their milling capacity, and a number of others are breaking into the rank of producers, so that a much greater production may be looked for in the year 1917. On every property without exception, where proper development work has been performed, the results have been most satisfactory. This augurs well for the future of the camp, which seems destined to attain even greater importance among the gold camps of the world. A very encouraging feature is the development work performed and results obtained on some properties in Deloro township. If these develop into mines, as they promise to do, it will greatly increase the producing area of the camp. Claims recorded 101, claims cancelled 408.

Larder Lake.—Fire destroyed the office on July 29th, and almost all documents were burned, but all records were saved. Mining continues very busy in this Division, and many new discoveries of merit were made during the year. Claims recorded 783, claims cancelled 157.

Port Arthur.—No new discoveries of much importance were made in this Division during 1916. Many of the prospectors have enlisted for overseas service. The withdrawal of a large portion of the Division from prospecting, and the establishment of the new Division of Kowkash have very much restricted the number of claims recorded. Several large options have been taken by "outsiders" on property in the vicinity of Big Duck lake, and some excellent deposits of gold are said to exist in that part. The gold-bearing rocks are said to extend from the Kowkash and Tashota areas southward along the east of the Nipigon Forest Reserve, and southeasterly to Big Duck lake. This part of the country has not been much prospected, but from reports brought in by experienced men it is probable that 1917 will show a great deal of mining activity between Big Duck lake and Kowkash. Claims recorded 172, cancelled 143.

Parry Sound.—Mica claims in the township of McConkey have been prospected with good results. The demand for potash and experiments undertaken for the utilization of feldspar in connection therewith, have resulted in many inquiries, and a few claims were recorded. Claims recorded 10, miner's licenses issued 36.

Gowganda.—H. E. Sheppard, Mining Recorder, having enlisted for active service, and also Albert Skill, the Recorder for the Montreal River Mining Division, the head office of Gowganda Division was moved to Elk lake, and Arthur J. Browning placed in charge of both Divisions. Business in 1916 was better than in 1915, due partly to the rise in the price of silver, and partly to the finding of a wonderful body of silver ore in the Miller-Lake O'Brien mine. The following properties were operated, in addition to the above mine: Reeve-Dobie, Bishop, Crews-McFarlan. The fire of last summer swept a wide area of the Division, and should make prospecting easier next year. Every care has been taken to see that the claims of enlisted men were safeguarded, but some cases have come to notice where holders have enlisted and have given no notification of the fact. Claims recorded 51, claims cancelled 362.

Montreal River.—A discovery of silver was made in the township of Auld, and great interest was aroused by the finding of gold in Powell township and surrounding territory, some 35 claims having been recorded up to the end of the year. This part of the country is best reached by river from Elk lake. The Kenabeek and Mapes-Johnston properties were worked during the year, and so also was the White Reserve. A large part of the Division was swept by fire last summer. Claims recorded 56, claims cancelled 190.

Timiskaming and Coleman.—There was a slight decrease of business as compared with 1915, accounted for by the great distress in northern Ontario caused by the forest fires, which prevented prospecting, and also the conditions brought about by the war in Europe. Most of the prospecting was done at Boston creek, and towards the close of the year there was some activity near Fort Matachewan, in the townships of Alma, Cairo and Powell. Claims recorded 156, cancelled 447.

Kenora.—Claims recorded 45, claims cancelled 33.

Kowkash.—Business was not brisk, only one mining company operating in the District, and many prospectors having enlisted. Rich discoveries have been made during the last two months. Claims recorded 160, claims cancelled 299.

Mining Companies

More mining and mineral companies were incorporated under the laws of Ontario in 1916 than in 1915, the number being 83 with a total capitalization of $109,079,500, as compared with 59 and an aggregate capital of $12,005,000. Foreign companies licensed to do business in the Province numbered eight with a capital for use in Ontario of $7,011,650, as against two the previous year with capital of $10,200,000.

The lists are as follows:-

MINING COMPANIES INCORPORATED IN 1916.

Name of Company.	Address.	Date of Incorporation.	Capital.
Algoma Construction & Engineering Co., Limited	Sault Ste. Marie	June 26.....	$100,000
Anzac Porcupine Mines, Limited	Toronto	Nov. 28.....	1,000,000
Atlas Gold Mines, Limited	Toronto	Feb. 17.....	2,000,000
Aurum Mines, Limited	Toronto	Oct. 18.....	1,500,000
Boston Creek Mining Company, Limited	Toronto	Feb. 7.....	2,000,000
Boston Gold Leaf Mining Company, Limited. ...	Cobalt	April 29.....	1,000,000
Bruce Mines Trap Rock Company, Limited	Sault Ste. Marie	June 26.....	150,000
Buff-Munro Gold Mines, Limited..............	Toronto	Dec. 6.....	3,000,000
Burton-Munro Mines, Limited	Toronto	Jan. 12.....	1,000,000
Canadian Mines Location and Development Company, Limited	Toronto	April 27.....	100,000
Canadian Molybdenite, Limited	Toronto	Sept. 21.....	100,000
Comfort Mining and Leasing Company, Limited	Cobalt	April 15.....	40,000
Consolidated Investments, Limited	Toronto	Nov. 15.....	60,000
Davidson Gold Mines, Limited	Toronto	Aug. 4.....	2,000,000
Davidson Lake Mining Company, Limited	Toronto	May 20.....	1,000,000
Dominion Rand Mines, Limited	Haileybury ...	Jan. 13.....	500,000
Elliott-Kirkland Gold Mines, Limited	Haileybury....	Dec. 2.....	2,000,000
Elstone Dunkin Mines, Limited	New Liskeard.	June 12.....	1,500,000
Empire State Mines, Limited	South Porcupine	Jan. 29.....	2,000,000
Federal Securities Corporations, Limited	Toronto	May 20.....	40,000
Feldspar and Clay Products, Limited	Wiarton	July 19.....	1,500,000
Frank Mapes Crittenden Company, Limited	Toronto	Oct. 10.....	50,000
Fulton Mines, Limited	Toronto	Oct. 4.....	500,000
Gold Bullion Mines, Limited	South Porcupine	Jan. 21.....	600,000
Groch Centrifugal Flotation, Limited	Cobalt	Dec. 1.....	25,000
Harland Development and Mining Co., Ltd. ..	Toronto	Dec. 14.....	40,000
Hodgson Brothers Chemical Company, Limited .	Lindsay	Mar. 10.....	200,000
Hoidge & Sons, Limited	Toronto	Dec. 19.....	60,000
Hollinger Consolidated Gold Mines, Limited ...	Toronto	May 25.....	25,000,000
Hudson Copper Company, Limited	Thessalon	Nov. 18.....	2,000,000
Humus Product Company, Limited	London	May 27.....	40,000
Inspiration Gold Mines, Limited	Toronto	Sept. 26.....	2,000,000
International Copper, Limited	Toronto	Jan. 22.....	150,000
Ixion Mines, Limited	Toronto	April 26	100,000
Kamiskotia Mining Company, Limited	Toronto	May 13.....	2,000,000
Kenyon Copper Mines, Limited	Toronto	Nov. 20.....	1,250,000
King Midas, Limited	Toronto	Nov. 18.....	2,000,000
Kingston Smelting Company, Limited	Kingston	Oct. 18.....	30,000
Kirk Gold Mines Company, Limited	Toronto	June 17.....	2,000,000
Kittinger Gas Company, Limited	Fort Erie	Jan. 5.....	40,000
McIvor Gold Mines, Limited	Kirkland Lake	Jan. 5.....	1,000,000
McRae Porcupine Gold Mines, Limited	Toronto	Feb. 29. ...	2,000,000
Milton Pressed Brick Company, Limited	Toronto	April 19.....	1,500,000
Mine Centre Copper Company, Limited	Port Arthur ..	Aug. 14.....	300,000
Murray Mogridge Mining Company, Limited ..	Toronto	Nov. 11.....	2,000,000
National Mines, Limited	Cobalt	Mar. 10.....	2,000,000
North Victoria Lead Mines, Limited	Toronto	May 5.....	19,500

MINING COMPANIES INCORPORATED, 1916.—*Continued.*

Name of Company.	Address.	Date of Incorporation.	Capital.
Ogistoh Mining Syndicate, Limited	Toronto	Dec. 12...	$40,000
Peerless Artificial Stone, Limited	Toronto	May 6..	40,000
Pinene Company, Limited	Cobalt	Nov. 24.	150,000
Porcupine-Nighthawk Mines, Limited	Toronto	Sept. 7.	1,000,000
Porcupine North Star Gold Mines, Limited ..	Toronto	Aug. 28....	2,500,000
Porcupine V.N.T. Gold Mines, Limited	Toronto	Dec. 5....	3,000,000
Port Arthur Copper Company, Limited	Toronto	Dec. 6....	2,500,000
Republic Gold Mines, Limited	Toronto	July 10...	3,000,000
Richmond Gas & Oil Company, Limited	Chatham	Nov. 22....	40,000
Scranton Lehigh Coal Company, Limited	Toronto	Mar. 3...	40,000
Sliverado Mining Company, Limited	Cobalt	June 16....	1,000,000
Sudbury Nickel, Limited	Sudbury......	Feb. 3. ..	100,000
Tash-Orn Mines, Limited	Toronto	Aug. 2. ..	3,000,000
The Acme Oil and Gas Company, Limited	Sarnia	Dec. 21.....	1,000,000
The Amm Natural Gas and Gasoline Co., Ltd...	Toronto	June 21.....	2,000,000
The Arnot Construction Company, Limited	Toronto	May 2.....	40,000
The Bellbirk Porcupine Mines, Limited	Toronto	Oct. 6.....	2,000,000
The Cashel Copper Mines, Limited	Toronto	Feb. 21....	850,000
The Caswell Mining Company, Limited	Toronto	April 15.....	1,000,000
The Hamilton Lumber & Coal Company, Limited	Hamilton	Dec. 2.....	150,000
The Indian Lake Lead Mining Company Limited	Toronto	Nov. 20.....	40,000
The Lakeshore Sand Company, Limited	Toronto	April 8.....	50,000
The Mattawan River Mining and Milling Company, Limited	Rutherglen ...	April 29.....	500,000
The North Thompson Gold Mines, Limited	Toronto	Feb. 19.....	1,375,000
The Ontario Gypsum Company, Limited	Paris..........	Dec. 11.....	750,000
The St. Catharines Machinery Co., Ltd.	St. Catharines.	Dec. 1.....	40,000
The Sudbury Copper Company, Limited	Toronto	Sept. 15.....	1,000,000
The Sun Chief Gowganda Silver Mines, Limited	Toronto	April 25.....	50,000
The Thessalon Copper Company, Limited	Toronto	Dec. 16.....	2,000,000
Thompson-Krist Mining Company, Limited	Toronto	Nov. 6.....	2,500,000
Thunder Mining Company, Limited	Toronto	Oct. 7.....	2,000,000
Twin Falls Lumber Company, Limited	Toronto	Aug. 15.....	200,000
Washed Sand and Gravel, Limited	Toronto	July 19.....	60,000
Welland Gas Company, Limited	Welland	Jan. 8.....	40,000
West Comstock Mining Company, Limited	Toronto	Nov. 9.....	3,000,000
Wright-Hargreaves Mines, Limited	Toronto	June 16.....	2,500,000
		Total......	$109,079,500

MINING COMPANIES LICENSED IN 1916.

Name of Company.	Head Office for Ontario.	Date of License.	Capital for use in Ontario.
Baldry Yerburgh and Hutchinson, Limited	St. Catharines.	May 31.....	$561,650
Deloro Smelting & Refining Company, Limited..	Toronto	Aug. 24.....	1,000,000
Dominion Mines and Quarries, Limited	Toronto	Feb. 25.....	150,000
E. J. Longyear Company	Sudbury	Mar. 16.....	30,000
International Metal Company	Tamworth	July 25.....	20,000
The Anglo-American Talc Corporation, Limited.	Madoc	Jan. 28.....	50,000
The Confederation Sand and Gravel Company, Limited	St. Catharines.	July 20.....	200,000
The Sudbury Nickel Refineries, Limited	Ottawa	Aug. 21.....	5,000,000
		Total......	$7,011,650

Mining Revenue

Revenue from mining sources for the fiscal year was $337,051.03, as compared with $342,986.44 in 1915. Following are the particulars:—

Sales of mining land	$36,578 69
Mining leases	16,218 36
Miners' licenses, fees, etc.	66,906 98
Mining royalties	15,083 52
Do. sand and gravel	14,680 41
Mining Tax Act	186,827 12
Provincial Assay Office	741 75
Refunds	11 20
Total	$337,051 03

Sales, Rentals, etc. Under the Mining Act the price of mining lands in unsurveyed territory is $2.50 per acre, and in surveyed townships $3.00 per acre. The Act requires the purchase price to be paid and patent taken out within nine months after the period expires for performing the last instalment of assessment work. Under the Mines Act of 1897 mining lands might be held either in fee simple or by lease, but since 1906 the law has authorized the issue of mining leases in forest reserves only. As a matter of fact such leases are now confined almost wholly to lands in the Timagami Forest Reserve.

Details of receipts from sales and leases of mining lands are given in the following table. The figures are not exactly the same as those given in the summary, since they include only sales and leases actually completed during the year, while the summary comprises all sums received.

MINING LANDS SOLD AND LEASED.

District.	Sales.			Leases.			Total.		
	No.	Acres.	Amount.	No.	Acres.	Amount.	No.	Acres.	Amount.
			$ c.			$ c.			$ c.
Timiskaming	219	7,990.38	19,943 14	103	3,868.78	3,868 78	322	11,859.16	23,811 92
Thunder Bay	50	2,012.04	4,396 63	....	....	....	50	2,012.04	4,396 63
Algoma	13	460.61	1,211 53	....	....	....	13	460.61	1,211 53
Sudbury	68	2,878.27	8,410 40	54	1,989.26	1,989 26	122	4,867.53	10,399 66
Nipissing	1	18.15	45 38	....	....	....	1	18.15	45 38
Kenora	23	872.66	2,094 20	....	....	....	23	872.66	2,094 20
Elsewhere	8	360.00	1,655 00	....	....	....	8	360	1,655 00
Total	382	14,592.11	37,756 28	157	5,858.04	5,858 04	539	20,450.15	43,614 32

Miners' Licenses, etc.—The fee for a miner's license is $5, but as all licenses expire on the 31st of March next after the date of issue, a license granted after the 1st of October in any year costs only $3. The fee for renewing a license is $5. For recording a claim the fee is $10. The receipts from miner's licenses and recording fees naturally increase in times when prospecting is active and speculation rife, and decline when the reverse is true. For a permit to prospect for minerals in a forest reserve, the regulations prescribe a charge of $10.

Royalties. This item, which applied to a few only of the silver mines of Cobalt, has now nearly disappeared, and will no doubt shortly disappear altogether. The mines on which it has levied have greatly diminished in production, and the rate of royalty has been reduced, thus enabling them to operate so long as there is any profit, or hope of profit. The chief royalty-paying mines are the O'Brien, Crown Reserve, Hudson Bay and Chambers-Ferland. The receipts from royalty in 1916 were from one mine only, the Crown Reserve. The total paid by this mine up to the end of the last fiscal year was $809,029.10, and the entire amount by all the royalty-paying mines was $1,903,993.96.

Rents and royalties from sand and gravel leases and licenses yielded in 1915-16 the sum of $14,680.11.

Mining Tax Act. Three sources of revenue are provided by this Act, as follows: (1) Acreage tax, consisting of 2 cents per acre levied on all mining lands situate in unorganized territory, which would otherwise, for the most part, entirely escape taxation; (2) an impost of 2 cents per thousand cubic feet on natural gas, with a rebate of 90 per cent. if the gas is used in Canada; the tax being in practice one of two-tenths of a cent per thousand cubic feet, since no gas is now piped out of the Province, and (3) a charge of 3 per cent. on the annual net profits of a mine in excess of $10,000.

These sources in 1916 produced the following amounts:—

Acreage Tax	$12,637 38
Gas Tax	33,630 14
Profit Tax	140,559 60
Total	$186,827 12

The total in 1914-15 was $177,101.53.

In view of the changes made by the Legislature in the Mining Tax Act at the session of 1917, it may be well to give the list of mines which have paid this tax, and the sums they have paid respectively. These will be found below. The tax began in 1907, and so has completed a full decade in its original form. The principal changes consist in (1) an increase in the tax from 3 to 5 per cent. where the net profits exceed one million dollars, (2) an increase from 3 to 5 per cent. on the profits from nickel-copper mines, and reckoning the profits as being the difference between the cost of production and the selling price of the refined products, the tax also being a graduated one over and above five million dollars, (3) increasing the proportion of the tax payable to the municipalities in which the mines are situated, from one-third to one-half. The acreage tax was also increased from 2 to 5 cents per acre.*

Following is a list of the mines which have paid the profit tax, showing the amount paid by each for the last fiscal year, and the total for the full period of the tax to 31st October, 1916.

*Mining Tax Act, 1917 (7 Geo. V., chapter 7). For a fuller discussion of Mining Taxation in Ontario, see Report of Royal Ontario Nickel Commission, 1917, pp. 506-528.

MINES WHICH HAVE PAID PROFIT TAXES.

Mine.	Paid in 1916.	Total 1907-16.
SILVER MINES.	$ c.	$ c.
Beaver	5,783 42	15,569 27
Buffalo	2,010 86	38,351 56
Casey-Cobalt	695 13	5,531 54
Coniagas	7,347 89	122,173 85
Cobalt Silver Queen	....	4,657 15
Cobalt Comet	2,988 37	4,930 39
Cobalt Lake (Mining Corporation of Canada)	....	12,750 60
Crown Reserve	1,885 48	1,885 48
Drummond	....	11,788 84
Foster	....	577 87
Kerr Lake	11,397 30	131,673 60
La Rose	4,042 21	139,562 13
McKinley-Darragh-Savage	1,529 88	78,988 73
Miller Lake O'Brien	1,992 26	11,036 22
Nipissing	22,519 27	252,426 83
Penn Canadian	7 90	391 72
Timiskaming	7,281 58	41,333 85
Trethewey	....	15,153 18
Seneca-Superior	9,014 48	23,443 70
Standard	....	1,447 00
Watts	....	258 69
Wettlaufer-Lorrain	....	19,054 45
Total	78,496 03	932,986 65
GOLD MINES.		
McIntyre-Porcupine	3,087 62	4,631 26
Dome	6,334 34	15,402 40
Tough-Oakes	6,690 80	6,690 80
Porcupine Crown	6,359 84	14,343 62
Acme	7,843 44	7,843 44
Hollinger	31,034 66	93,112 04
Porcupine Vipond	216 21	216 21
Total	61,566 91	142,239 77
NICKEL-COPPER MINES.		
Alexo	496 66	806 59
Canadian Copper Company	....	245,000 00
Mond Nickel Company	....	18,226 94
Total	496 66	264,033 53
MISCELLANEOUS.		
Lake Superior Corporation (Iron)	....	1,683 51
Loughborough Mining Company (Mica)	....	216 21
Total	....	1,899 72
SUMMARY.		
Silver Mines	78,496 03	932,986 65
Gold Mines	61,566 91	142,239 77
Nickel-Copper Mines	496 66	264,033 53
Miscellaneous Mines	....	1,899 72
Total	140,559 60	1,341,159 67

It should be pointed out that the royalty-paying mines are exempted from the 3 per cent. profit tax, and are therefore not included in the foregoing list, except in cases where the royalty was removed on the mine nearing exhaustion, when the tax took effect.

The following notes on the operation of the Mining Tax Act for 1916 are furnished by Mr. Mickle, Mine Assessor, who from the passing of the Act has had charge of collecting the revenue:—

The Mining Tax Act, which levies three different taxes, yielded the amounts mentioned below for the year 1916. The sums stated are those payable for the year 1916, and collected in the case of the Profit and Natural Gas Tax, although some of the taxes would be paid after the close of the fiscal year for the Province on the 31st October, and consequently will not agree with the statements given in the Public accounts.

1. Profit Tax (not including amounts payable by the two principal nickel companies	*140,867 55
2. Natural Gas Tax	30,336 17
3. Acreage Tax (April 15th, 1916 April 15th, 1917)	12,080 91
Total	$183,284 63

With regard to the Profit Tax, this has been at the rate of three per cent., with certain deductions for taxes paid municipalities. Substantial alterations having been made by the Legislature, particularly with regard to nickel mines, and these amendments applied to the year 1916, taxes have not been collected from companies operating nickel mines for 1916 up to the present. On the basis hitherto in force the amount of Profit Tax would have been about $90,000 greater than given above. The levy for 1916 is slightly greater than for 1915, even without the tax from the nickel companies.

With reference to the operations of the Profit Tax, as material alterations were made in the Act and comparisons of results in the future will be of little value, it seems opportune to review briefly the results obtained during the ten years it has been in force, from 1907 to 1916. By calendar years the returns were as follows:

1907	$66,741 68
1908	65,922 48
1909	78,327 58
1910	111,546 17
1911	131,577 75
1912	200,275 25
1913	206,212 77
1914	201,940 20
1915	138,056 20
1916	140,867 55
Total	$1,341,467 63

* Not including tax from nickel companies.

Revenue from this tax has been obtained almost entirely from three classes of mines, viz., silver, nickel-copper, and gold mines. The profit on production of all other kinds of ores has yielded only an insignificant portion. The total taxes for the ten years in question have been as follows:—

Silver mines	$933,746 59
Nickel-copper mines	264,033 53
Gold mines	140,696 13
Miscellaneous mines	2,991 38
Total	$1,341,467 63

The tax from silver mines reached its maximum of $156,000 approximately in 1912; since then it has declined to about one-half that amount. For the future, as the proportion of the Profit Tax which may be deducted from the Provincial tax has been substantially increased, viz., from one-third to one-half in most cases, there will be a consequent equal

reduction of the amount accruing to the Province of about 25 per cent. This will apply also to gold mines.

With regard to the nickel-copper mines, the amount given is for nine years, not ten, the last year being very much the best. For the future the tax, both with respect to rate and basis of computation, is totally different. Moreover, for the greater part of the taxes payable under the new legislation, the amount which might be deducted from the Provincial tax on account of municipal expenditure, instead of being one-third, will be probably one-twentieth.

Coming to the gold mines, these first contributed to the Profit Tax in 1913. The amount paid yearly has increased greatly, and in 1916 was about $62,000.

The tax on natural gas, which is a fixed amount equivalent to $2.00 per million cubic feet, is gradually increasing at the rate of about 10 per cent. per year, mainly due to the increased production from one field. Unless new discoveries are made, the tax must decline in the course of the next few years.

Respecting the acreage tax, a substantial change was also made in this by the Legislature, the rate being increased from two to five cents per acre and the tax made applicable to lands in organized territory in which the mineral rights have been severed from the surface rights. Hitherto such mineral rights were only taxable in unorganized territory, that is, with no municipal organization. The number of acres affected by this change cannot be estimated yet. Information is being compiled by various Local Masters of Titles on this point.

Provincial Assay Office

Following is a report on the Provincial Assay Office for 1916, by W. K. McNeill, B.Sc., Provincial Assayer. The office is operated in connection with the Bureau of Mines.

The work of the Provincial Assay Office, No. 5 Queen's Park, Toronto, is as follows:—

(*a*) Examination and assaying of samples from mining engineers, prospectors, geologists, and the public generally.

(*b*) Work for the Ontario Bureau of Mines, consisting of analyses of rocks, assaying of different ores and identification of minerals for the geologists employed by the Bureau.

(*c*) Testing samples submitted by the public for radium. This work is done free of charge.

(*d*) Sampling car lots of cobalt-silver ore, upon which the Government collects a royalty. This necessitates having a sampler at Deloro for a large part of the time.

(*e*) Assaying and valuating of these car lots.

(*f*) Analyzing and valuating shipments of cobalt and nickel compounds shipped by various smelters and on which a bounty is paid.

The work may be further classified as follows:

Gold.—450 samples were assayed for gold and reports issued.

Silver.—72 samples of silver were submitted, including car lots of cobalt-silver ore, upon which the Government collects a royalty.

Platinum.—9 samples were submitted for assay for platinum.

Iron.—46 samples of iron ore were analyzed for iron, also for sulphur and phosphorus.

Copper.—61 samples. During the year a greater interest was manifested in this metal, as shown by assays and inquiries received for information.

Nickel.—64 samples. In addition, analyses were made in experiments conducted for the Royal Ontario Nickel Commission.

Rock samples.—17 rock samples were submitted by the geologists of the Bureau of Mines for complete analyses.

General.—278 other samples were received, including samples for cobalt, molybdenum, zinc, lead, etc.

In addition to the work designated above, shipments of cobalt and nickel oxides from the various smelters were analyzed and valuated.

This office also conducted experiments and analyzed samples for the Ontario Nickel Commission.

The Provincial Assayer had charge of the Mineral Exhibit of the Ontario Bureau of Mines at the Canadian National Exhibition, and was assisted by Professor Ledoux of Toronto University. They desire to thank the mine owners and managers who kindly loaned samples, and in other ways contributed to the success of the Exhibition.

The work was carried on with the following assistance: T. E. Rothwell, B.Sc., Assistant Provincial Assayer; L. W. Todd, B.Sc., who was employed for two months, and A. Leat for six months.

In assaying for the public, samples will be dealt with in the order of their [illegible]. In every instance specimens and samples should be accompanied by statement specifying the precise locality whence they were taken.

Crushed samples representing large quantities or samples less than five pounds weight may be sent by mail as third-class matter. Write name and address plainly on each parcel. Send instructions, with money in payment of fees in a separate letter. Samples may be sent by express, charges prepaid.

Sample bags addressed to this Laboratory for sending ore pulp by mail may be obtained free on application; also canvas bags for shipping.

Money in payment of fees, sent in by registered letter, post office order, postal note, or express order, and made payable to the Provincial Assayer, must invariably accompany sample to insure prompt return of certificate, as no examination is commenced until the regulation fee is paid.

Samples should be addressed as follows: "To Provincial Assay Office, 5 Queen's Park, Toronto, Ont."

TARIFF OF FEES FOR ANALYSES AND ASSAYS.

1. *Assays:*

Gold	$1 00
Silver	1 00
Gold and Silver in one sample	1 50
Platinum	4 00
Gold and Platinum in one sample	5 00
Gold by amalgamation	2 00

For the amalgamation assay for gold at least five pounds of ore must be sent.

2. *Iron Ores:*

Iron (metallic)	$1 00
Silica	1 50
Iron and insoluble residue	1 50
Ferrous Oxide	2 00
Phosphorus	2 00
Sulphur	2 00
Iron, Sulphur, Phosphorus and insoluble	5 00
Manganese	2 00
Titanium	2 00
Complete analysis:—Ferrous Oxide, Ferric Oxide, total Metallic Iron, Silica, Alumina, Lime, Magnesia, Manganese, Phosphorus, Sulphur and Titanium	15 00

3. *Limestones, Dolomites, Marls, Clays, Shales:*

Determination of:

Insolubles	$1 00
Silica	1 50
Ferric Iron	2 00
Ferrous Iron	2 00
Alumina	2 00
Lime	1 50
Magnesia	1 50
Alkalies (combined)	5 00
Potash	4 00
Water (combined)	1 00
Moisture	0 50
Organic Matter	1 00
Carbon Dioxide	1 50
Sulphur	2 00
Phosphorus Anhydride	2 00

4. *Examination of Clay, Shale, or Cement Rock for Cement Manufacture:*

Determination of:

Silica, Iron Oxide, Alumina, Lime, Magnesia, Sulphuric Anhydride and Volatile Matter	$10 00

5. *Coal, Coke, Peat, etc.:*

Determination of:

Moisture	$0 50
Volatile Combustible	1 00
Fixed Carbon	1 00
Ash	1 00
Sulphur	2 00
Phosphorus	2 00
Calorific Value	5 00
Ultimate Analysis	Price on Application

6. *Mineral Waters* .... Price on Application

7. *Ores and Minerals:*

Determination of:

Alumina	$2 00
Antimony	3 00
Arsenic	3 00
Bismuth	3 00
Cadmium	3 00
Chromium	3 00
Cobalt	3 00
Copper	2 00
Gold	1 00
Ferrous Oxide	2 00
Ferric Oxide	2 00
Lead	2 00
Lime	1 50
Magnesia	1 50
Molybdenum	2 00
Manganese	2 00
Nickel	3 00
Silica	1 50
Water	1 00
Zinc	2 00

8. *Rocks, Complete Analysis* .... Prices on Application

9. *Slags, Sand, etc.* .... Prices on Application

10. *Identification of Minerals and Rocks not Requiring Chemical Analysis*.... Free

Any analytical work not specified above will be undertaken on application to the Provincial Assayer.

The pulp of each sample is retained for future reference.

MINING ACCIDENTS IN 1916

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, E. A. Collins, Kingston; James Bartlett, Cobalt; J. H. Stovel, Sudbury

During the year 1916 at the mines, metallurgical works, quarries, clay and gravel pits regulated by the Mining Act of Ontario there were 45 fatal accidents causing the death of 51 men, as compared with 22 deaths in 1915 and 58 in 1914. Of these, 24 accidents resulting in 30 deaths occurred underground. Seven men were killed above ground at the mines, eight men were killed at the metallurgical works and six men at the quarries.

Eighteen companies had fatal accidents during the year.

Particulars of the fatal accidents during 1916 were given in Bulletin No. 30 of the Ontario Bureau of Mines.

The report of the Workmen's Compensation Board for 1916 shows that 1,319 claims for compensation in Class 5, Schedule 1[1] were handled by the Board during the year, of which 87 claims were for permanent disability.

Table 13 of the report shows that 21,869 days were lost through accidents; that the average of age of the injured was 31.10 years and the average weekly wages $18.21.

Table 15 gives the nature of the injuries. Of 1,114 temporary disability cases finally disposed of, the causes were classified as follows:

Bruises, contusions and abrasions	314
Cuts and lacerations	283
Fractures	99
Crushes	109
Sprains, strains, etc.	101
Burns and scalds	108
Punctures	28
Eye injuries	47
Hernias	5
Internal injuries	5
Dislocations	10
All other injuries	2
Industrial diseases	3
Total	1,114

The fatal accidents in connection with the mineral industry for the last three years were as follows:

Table of Fatalities

	1914	1915	1916.
Mines, underground	29	17	30
Mines, surface	9	4	7
Metallurgical works	5	1	8
Quarries	15	0	6
Totals	58	22	51

[1] Class 5.—Mining; reduction of ores and smelting; preparation of metals or minerals; boring and drilling including sinking of artesian wells (except when done by an employer coming under Class 14); manufacture of calcium carbide, carborundum or alundum, abrasives or abrasive articles other than stone.

The fatalities at the mines were divided amongst the several districts as follows:

	1914	1915	1916
Gold mines of Porcupine and Kirkland Lake..	12	3	14
Silver mines of Cobalt and adjacent districts.	11	6	8
Nickel-copper mines of Sudbury	9	11	[illegible]
Iron mines of Michipicoten	4	0	2
Western Ontario	1	0	[illegible]
Eastern Ontario	1	1	0
Totals	38	21	37

By months the fatalities occurred as follows:

	1914	1915	1916
January	6	0	7
February	5	3	4
March	7	0	1
April	7	4	2
May	5	0	7
June	8	1	5
July	4	2	1
August	5	3	2
September	2	3	3
October	3	3	1
November	4	1	10
December	2	2	8
Totals	58	22	51

Analysis of Fatalities at Mines

Cause.	1914	1915	1916
	Per cent.	Per cent.	Per cent.
Falls of ground....................................	7.9	4.8	24.3
Shaft accidents....................................	26.3	23.8	27.0
Explosives...	26.3	33.3	21.6
Miscellaneous underground..........................	15.8	23.8	8.1
Surface..	23.7	14.3	18.9

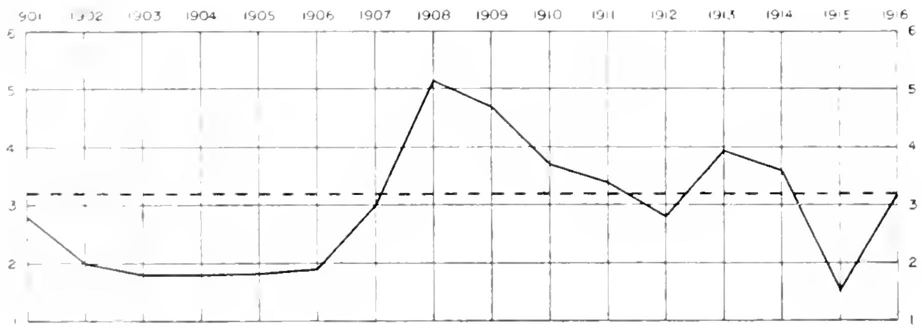


Diagram showing Mining Fatalities per thousand men employed between the years 1901-1916. The dotted line represents the average for the period.

Table of Fatal Accidents in Mines, Metallurgical Works and Quarries, 1901 to 1916

—	Persons killed at metallurgical works and mines.	Persons employed at metallurgical works and producing mines.	Persons employed at non-producing mines (estimated).	Total persons employed.	Fatal accidents per 1,000 employed.
1901........	13	4,135	550	4,685	2.77
1902........	10	4,426	450	4,876	2.05
1903........	7	3,499	400	3,899	1.79
1904........	7	3,475	400	3,875	1.80
1905........	9	4,415	500	4,915	1.83
1906........	11	5,017	750	5,767	1.90
1907........	22	6,305	1,140	7,445	2.93
1908........	47	7,435	1,750	9,185	5.11
1909........	49	8,505	2,000	10,505	4.66
1910........	48	10,862	2,000	12,862	3.73
1911........	49	12,543	2,000	14,543	3.37
1912........	43	13,108	2,000	15,108	2.84
1913........	64	14,293	2,000	16,293	3.93
1914........	58	14,361	1,500	15,861	3.60
1915........	22	13,114	1,500	14,614	1.51
1916........	51	14,624	2,000	16,624	3.07
Totals ..	510	140,117	20,910	161,057	3.16

The occupation and nationality of the men killed are set out in the following table:

Occupation.	English Speaking.	Italian.	Austrian.	Russian.	Finn.	German.	Spaniard	Swede.	Total.
Labourer	6	3	2	2	.....	.....	....	1	14
Machine runner..	3	1	2	1	2	1	....	.....	10
Trammer........	3	....	1	1	.....	.....	....	.....	5
Machine helper ..	1	....	1	....	.....	1	....	.....	3
Chute blaster	1	....	....	2	.....	.....	....	.....	3
Foreman	3	....	....	....	.....	.....	....	.....	3
Blockholer	....	....	1	....	1	......	1	.....	3
Millman	1	1	....	....	.....	.....	....	.....	2
Scaler..........	....	....	....	1	1	.....	....	.....	2
Timberman	1	....	....	....	.....	.....	....	.....	1
Hoistman	1	....	....	....	.....	.....	....	.....	1
Helper	....	1	....	....	.....	.....	....	.....	1
Electrician.......	1	....	....	....	.....	.....	....	.....	1
Crusherman......	....	1	....	....	.....	.....	....	.....	1
Teamster........	1	....	....	....	.....	.....	....	.....	1
Totals.......	22	7	7	7	4	2	1	1	51

The ages of the men ki d were as follows:

17–20	21–25	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	Total.
3	11	6	17	4	6		1	1	1	51

Table of Fatal Accidents in

No.	Date 1916	Name of Mine	Name of Owner	Name of Deceased	Occupation of Deceased
1	Nov. 4	Adanac	Adanac Silver Mines	N. Lamoureux	Machine helper
	" 4	do	do do	E. Sturgeon	Machine runner.
2	Jan. 3	Magpie	Algoma Steel Corpn.	I. Gaetano	Millman.
3	Dec. 29	do	do do	I. Piazza	Machine runner.
4	Nov. 22	Cyril Lake	Calumet and Montana Consolidated	F. Contymyr	Machine runner.
	"	do	do do	T. Yorke	Machine helper
5	Jan. 16	Creighton	Canadian Copper Co.	S. Docenka	Chute blaster
6	Feb. 22	do	do do	S. Oslapowicz	Trammer
7	Mch. 31	do	do do	R. McDonald	Machine runner.
8	April 2	do	do do	M. Aab	Scaler
9	May 4	do	do do	C. O'Connor	Foreman
	"	do	do do	S. Minta	Machine runner.
	"	do	do do	J. Kusch	Machine helper
10	" 12	Crean Hill	do do	G. Korol	Machine runner.
11	Aug. 26	do	do do	W. Powlowski	Blockholer
12	Nov. 3	Creighton	do do	J. Ballister	Blockholer
13	Dec. 18	do	do do	A. Auver	Scaler
14	Dec. 16	Mill	Cobalt Reduction Co.	J. Bellerby	Millman.
15	Jan. 4	Dome	Dome Mines Co.	E. Wallace	Timberman
16	Jan. 21	do	do do	J. H. Smeltzer	Foreman
	" 21	do	do do	M. Cahill	Foreman
	" 21	do	do do	B. Deshales	Machine runner.
17	May 15	do	do do	S. Maki	Blockholer
18	July 12	do	do do	F. Chapman	Hoistman
19	June 9	Foster	Glen Lake Cobalt Mines, Ltd.	S. Labelle	Trammer
20	June 20	Hollinger	Hollinger Consolidated Gold Mines	J. Ormelchock	Machine runner.
21	Sept. 6	do	do do	H. Rheault	Laborer
22	Nov. 4	do	do do	M. Therien	Trammer
23	" 12	do	do do	F. Kusi	Machine runner.
24	Dec. 27	do	do do	G. Mudato	Chute blaster
25	May 8	La Rose	La Rose Mines	A. Belanger	Laborer
	Nov. 7		McKinnon & Ogilvie	J. Cullan	Laborer
26	Dec. 6	Townsite	Mining Corporation of Canada	W. Crubak	Trammer
27	Feb. 3	Bruce	Mond Nickel Co.	G. Simmonds	Trammer
28	Aug. 12	Levack	do do	A. Twerdochlibe	Laborer
29	April 25	Crown	Porcupine Crown Mining Co.	D. Chisholm	Blaster
30	Feb. 26	Vipond	Porcupine Vipond Mines	A. Peldaga	Machine runner.

or about the Mines, 1916

Nationality of Deceased.	Age.	Married or single.	Below ground.	Above ground.	Cause of Accident.
English-speaking ...	26	S	1	...	Struck by crosshead while riding bucket.
English speaking	30	M	1	...	
Italian	27	S	.....	1	Fell while oiling in coal grinding plant.
Italian	40	......	1	......	Struck by fall of ore.
Austrian	43	M	1	....	Premature explosion while firing round.
Austrian	38	M	1	....	
Russian	32	M	1	......	Premature explosion while sand blasting.
Austrian	32	M	1	......	Crushed between ore train and side of drift.
English-speaking	25	S	1	......	Caught by station timber and swept off skip
Russian	25	S	1	.....	Slipped on ice and fell while inspecting incline shaft.
English-speaking	34	S	1	....	Fall of ground in stope.
German	24	S	1	....	
German	21	S	1	....	
Austrian	34	M	1	.....	Caught in stope when round fired.
Austrian	22	M	1	......	Drilled into explosive while blockholing.
Spaniard	28	S	1	......	Struck by fall of ore while blockholing.
Finn	24	S	1	......	Caught by fall of ground while sealing.
English-speaking	60	M	.....	1	Electrocuted in mill, touched terminal of 3-pole switch.
English-speaking	32	S	1	......	Slipped and fell while timbering in No. 3 shaft.
English-speaking	32	M	1	....	Raise to bottom of shaft blocked. Jam broke while men were in shaft standing over raise attempting to start it.
English-speaking	34	S	1	....	
English-speaking	22	S	1	....	
Finn	32	S	1	......	Struck by falling bucket in shaft.
English-speaking	35	M	.....	1	Caught between spur wheel and pinion of indicator gear of hoist.
English-speaking	42	M	1	......	Struck by slab of rock from footwall of stope.
Russian	32	M	1	......	Struck by rock which fell from back of drift.
English-speaking	25	S	.....	1	Fell from scaffold on headframe at central shaft.
English-speaking	18	S	1	.....	Fell into stope.
Finn	23	S	1	......	Returned too soon after blasting and caught by second explosion.
Russian	41	M	1	......	Premature explosion while sand blasting.
English-speaking	25	S	.....	1	Crushed between two cars on railway siding.
English-speaking	65	M	.....	1	Struck by falling tree.
Russian	52	M	1	......	Caught by run of ore in stope.
English-speaking	45	M	1	......	Struck by skip while cleaning out sump.
Austrian	47	M	.....	1	Struck by bar while barring chute in rock house.
English-speaking	33	S	1	......	Gassed in raise while refiring holes.
Finn	37	S	1	.....	Struck by fall of ground while drilling.

Table of Fatal Accidents at

No.	Date. 1916.	Works	Name of Owner.	Name of Deceased.	Occupation of Deceased.
31	Jan. 27	Roast yards	Canadian Copper Co.	E. Sandholm	Laborer
32	Feb. 16	Smelter	do do	A. De Bartoli	Laborer
33	Sept. 21	do	do do	A. Destifano	Helper
34	June 1	do	Mond Nickel Co.	W. J. Perrin	Electrician
35	Oct. 1	do	do do	C. Mazuck	Laborer
36	Nov. 3	Roast yards	do do	N. Kozoriz	Laborer
37	Dec. 2	Smelter	do do	E. Grenier	Laborer
38	Dec. 12	do	do do	F. Rosera	Crusherman

Table of Fatal Accidents

No.	Date. 1916.	Works	Name of Owner.	Name of Deceased.	Occupation of Deceased.
39	June 15	Washing plant	Armstrong Supply Co.	P. English	Teamster
40	Sept. 14	Crushing plant	Canada Crushed Stone Corporation	S. Farrow	Laborer
41	Nov. 22	do	do do	T. Fillipe	Laborer
42	June 26	Screening plant	Roesand Company	G. Berry	Laborer
43	May 11	Quarry	Standard Crushed Stone Co.	A. Ceccarelli	Laborer
44	Dec. 27	Sand pit	Hollinger Consolidated Gold Mines	F. S. Cotmeix	Laborer

Metallurgical Works, 1916

Nationality of Deceased.	Age.	Married or single.	Cause of Accident.
Swede	22	S	Knocked off flat car and [illegible]
Italian	35	M	Fell into ore bin.
Italian	33	M	Received shock while repairing crane [illegible] fourteen feet. Died October [illegible]
Italian	28	S	Electrocuted in transformer house.
Russian	29	M	Knocked off car and run over.
Austrian	42	M	Struck by flying material from blast.
English-speaking	20	S	Crushed by converter room crane.
Italian	35	M	Killed while applying belt dressing.

at Quarries, 1916

English-speaking ...	40	S	Suffocated in sand bin.
English-speaking	35	M	Adjusting belt on moving pulley.
Italian	19	S	Killed while applying belt dressing.
English-speaking	32	S	Adjusting belt on moving pulley.
Italian	43	M	Run over by car.
Russian	[illegible]	M	Killed in sand pit.

MINES OF ONTARIO

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, E. A. Collins, Kingston; J. H. Stovel, Sudbury; Jas. Bartlett, Cobalt

I. NORTH-WESTERN ONTARIO

Iron Pyrites

Minnitaki Lake.—Jas. Whalen, of Port Arthur, is sinking a hundred-foot shaft on a pyrites deposit located near the shore of Minnitaki Lake, south-west of Graham station on the Canadian Government railway. Previous diamond drilling on this property had shown a considerable body of high-grade ore.

Northern Pyrites Mine.—The Northern Pyrites Company, at present controlled by the General Chemical Company of New York, operated their mine, at Northpines, Ontario, continuously throughout the year. During the season of navigation about 70,000 tons were shipped to the various plants of the General Chemical Company in the United States. Extensive alterations to the power plants, etc., carried on during the summer months, curtailed the output.

The new power house, of steel frame and hollow tile construction, containing five boilers, two compressors, mill engine, electric generators, etc., has now been completed. The additional air capacity, due to the installation of a second air compressor, will permit of larger shipments being made in the future. Alterations to concentrating mill during the coming winter will enable some lower grade ore to be handled.

In November, Mr. H. V. Smythe, who had been superintendent of this property for the past six years, was appointed general superintendent of mines, with jurisdiction over all the General Chemical Company's and the Nichols Chemical Company's mining interests in Canada. His office is with the Nichols Chemical Company, Limited, at Montreal. G. B. Holderer succeeded Mr. Smythe as superintendent of the Northern Pyrites Company. About 125 men are employed continuously at the property.

Mokomon.—The above company are diamond-drilling a pyrites prospect at Mokomon in Conmee township about 23 miles north of Fort William. Dr. Warren S. Smith, of the General Chemical Company's geological staff, is personally directing this work.

Copper

Port Arthur Copper Company.—Early in June, 1916, a copper deposit was discovered about four miles west of Mine Centre and one-half mile south of the main line of the Canadian Northern railway. This property was worked in a small way, until the end of November, by J. F. Hewitson, of Port Arthur, and J. A. Johnson, of Mine Centre. A force of about twelve men were employed, and eight

carloads were shipped to Trail, B.C. The workings consisted of a small open cut. Two small boilers, a hoist and a small compressor had been placed on the property. At end of November, F. M. Connell, of Toronto, acquired control, and has organized the Port Arthur Copper Company.

Gold

St. Anthony Mine.—Until September, 1916, this property was being developed, under option to purchase, by a company known as The St. Anthony Development Company, which was controlled by the Kerr Lake Mining Company and the Wettlauffer-Lorrain Company, both of 61 Broadway, New York. One hundred feet of sinking and several hundred feet of drifting and cross-cutting were done by this company. This work blocked out a considerable tonnage of good ore. M. C. H. Little had charge of the work. The option was allowed to expire in September.

In September the property was taken over by a company organized for that purpose and known as the Thunder Mining Company, Limited. This company has a capitalization of one million shares of $1.00 each and $140,000 first mortgage bonds. The officers are: D. M. Steindler, president; E. H. Westlake, vice-president, and Eugene L. Steindler, sec.-treas. H. H. Lavery, St. Anthony Mine P.O., *via* Fort William, Ont., is superintendent. Development only will be undertaken in the year and a half before the final payment is due. From 50 to 70 men are employed. The mine is situated on Sturgeon lake, and is reached from Bucke station on the Canadian Government railway.

Tash Orn.—The Tash Orn Mines, Limited, is developing the Wells gold claim (T.B. 2892) about a mile southeast of Tashota station on the National Transcontinental railway.

A shaft has been sunk 115 feet and 350 feet of drifting and cross-cutting done on the 100-foot level. Two boilers have been installed; also a small hoist and an air compressor.

The company is incorporated in Ontario for $3,000,000. Mr. Castleberg is president, and John L. Orn treasurer and managing director.

II.—SUDBURY, NORTH SHORE AND MICHIPICOTEN

Iron Ore

Helen.—Operations at this property of the Algoma Steel Corporation consisted of drawing off the caved hematite ore. This ore was mostly shipped to the Magpie mine, where it was roasted to reduce the sulphur content. In addition some pyrites was obtained and shipped to the acid plant at Sault Ste. Marie. During the year diamond drilling was continued on the siderite deposit which lies to one side of, as well as underneath, the hematite deposit at the Helen. A very large tonnage of siderite has been proven by the drilling, and plans for the development of this are under way.

G. R. McLaren, Helen Mine, Ont., is superintendent. About 110 men were employed.

Magpie.—The Magpie mine, of the Algoma Steel Corporation, operated continuously during the year. The roasting plant was kept going to its full capacity, between 900 and 1,000 tons daily, of raw ore. Considerable ore, running high in sulphur, from the Helen mine was dumped down an old stope, hoisted and mixed with Magpie ore and then roasted. Most of the ore hoisted came from above the second level, but mining was carried on in one stope above the third level. The balance of the third level was being developed. The shaft was sunk to below the fourth level, the fourth level station cut and a cross-cut run through the ore. Development on this level will be pushed as soon as the timbering in the shaft is completed. It is worth noting that the method of mining used at the Magpie mine appears to be one of the safest as well as one of the cheapest in use in Ontario.

A. Hasselbring, general superintendent of mines for the Algoma Steel Corporation, is in charge at the Magpie. About 250 men were employed at the property.

Nickel and Copper

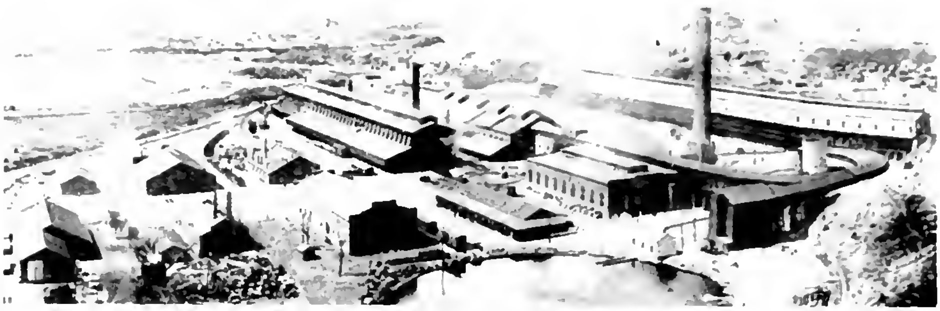
The Canadian Copper Company. The Canadian Copper Company operated, during 1916, the following mines: Creighton, Crean Hill, No. "2," Vermilion, and the Dill quartz quarry. The first four in the above list shipped 1,328,076 tons to the Copper Cliff smelter. This is almost 100,000 tons in excess of the shipments in 1915, the previous record year.

The officials of the company are: President, A. D. Miles; general superintendent, J. L. Agnew; superintendent of mines, J. C. Nicholls; assistant superintendent of mines, J. P. Hussey; chief engineer, E. H. Jones; chief metallurgist, J. W. Rawlins; safety engineer, E. T. Corkill.

Copper Cliff Smelter.—The Copper Cliff smelter was run to capacity, and, like the mines of the company, handled a much larger tonnage than in any previous year. No changes of importance were made. Plans are now under way for installation of additional furnaces of larger capacity than those in service.

All told, about 1,000 men are employed at the smelter. W. Kent is smelter superintendent.

Roast Yards.—The old roast yards at Copper Cliff were abandoned late in the spring of 1916. The new yards are situated at O'Donnell, mileage 17 on the Algoma Eastern railway. There are three parallel tracks, 6,000 feet long, spaced about eighty feet apart. The roast beds are made up in units of a hundred feet in length in the space between the tracks. Two feet of cordwood is placed in the bottom of each bed, then about eight feet of coarse ore is piled on this. A thin coating of ore fines is spread on the top of the beds. It takes about three months to complete the roasting of a bed. The ore is moved from flat cars, on which it is shipped, to the roast piles by contract. Some ore is shovelled directly on to the bed, but the major portion is handled by means of wheelbarrows. When inspected in August between sixty and seventy thousand tons were being handled monthly. The roast beds have a total capacity of 350,000 tons.



General view of Copper Cliff smelting plant.

General view of blast furnace and converter departments, Copper Cliff.

Between the roast beds and the Algoma Eastern railway a large sorting and storage yard is provided, the weighing scales being at this point.

About 150 men are employed.

Vermilion.—The Vermilion mine was operated throughout the year. It was shut down at end of January, 1917, as, owing to shortage of labour, it was thought advisable to use the labour in the larger producing mines. During this period 2,750 tons of ore were shipped to the smelter at Copper Cliff. The ore stoped was obtained in the upper 100 feet of the mine. No sinking was done.

Charles Collins, of Crean Hill, is superintendent. From 10 to 15 men were employed.

Dill Quartz Quarry.—The Canadian Copper Company operated their quartz quarry in Dill township from the first of April to the end of November. 51,113 tons of quartz were shipped to the Copper Cliff smelter.

H. Whitehead, Quartz, Ont., is superintendent. Forty-five men were employed.

Number 2.—Number 2 mine was operated continuously during 1916, but was shut down at end of January, 1917. In that period 66,550 tons of ore were shipped. During the year the sixth and the ninth level floors were taken out. This ore was all drawn out at the tenth level. The mine, when closed down, had a continuous open pit from surface to the tenth level, and the mine superintendent, W. J. Hambly, claimed a 100 per cent. recovery of the ore above that point. All pumps and machinery have been removed from the mine.

W. J. Hambly, Copper Cliff, was superintendent. About 75 men were employed.

Crean Hill.—Crean Hill mine shipped 174,995 tons during 1916. This came mostly from the extensions of the original open pit, above the second level, and from the fourth, fifth and sixth level stopes. No stoping was done below the sixth level. The work of changing the shaft from a three-compartment to a four-compartment shaft was completed from the sixth level to the ninth level.

An addition to the power house was built and a third compressor, of 2,500 cubic feet capacity, was installed. Also a small machine shop was built and equipped.

Charles Collins, Crean Hill, Ont., is superintendent. An average of 500 men was employed.

Creighton.—The Creighton mine shipped 1,084,301 tons of ore in 1916. This was an increase of more than 300,000 tons over the production of the previous year, and more than double the production of 1914. Some ore was obtained from the old third level floor in the open pit, also in working out the end of the ore body between the third and the fifth levels. Stoping in the west ore body between the fifth and sixth levels was continued during the year, but the production was relatively small. In the early part of the year, the main production was from the broken ore reserves above the sixth level. In the latter part of the year the main production was from

Creighton nickel-copper mine, Canadian Copper Company.

the stopes between the tenth and the sixth levels. Considerable ore was obtained from development on the twelfth level, where four stopes were partly developed and stoping begun. Development ore from this level was handled through two winzes from the tenth level.

The larger part of the stoping during the year was carried on between the tenth and the eighth levels, but a great deal of stoping was done in other parts of the mine.

Sinking on No. 3 shaft was stopped at the eighteenth level at a depth of 1,410 feet on the 55 degree incline or 1,155 vertical depth. Stations were cut in this shaft at the 6th, 8th, 10th, 12th, 14th and 16th levels. The shaft has been connected up to the main workings on the 6th, 8th, 10th and 12th levels. The skips in No. 2 shaft do not reach the 12th level, but the manway in this shaft does. Waste pockets were cut in No. 3 shaft on the 14th and 16th levels. An ore crusher pocket was cut on the 14th level. When this shaft is in commission, all ore will be passed down through this crusher before it reaches the loading pockets. Timbering was carried on in this shaft in the latter part of the year, and is now nearly completed. The shaft track consists of 85-pound rails resting on wall plates which are of 8 x 10 inches B.C. fir. These are spaced five and six feet apart. At intervals of thirty feet there will be put in concrete piers, which will serve to anchor the timbering. In addition to the waste and ore pockets on the 14th level, two development cross-cuts were begun, and the material from these was handled through this shaft. The seven-ton skips in No. 3 shaft will discharge directly into the new rockhouse, which is described elsewhere.

Motor haulage is now used on the 6th, 8th, 10th and 12th levels.

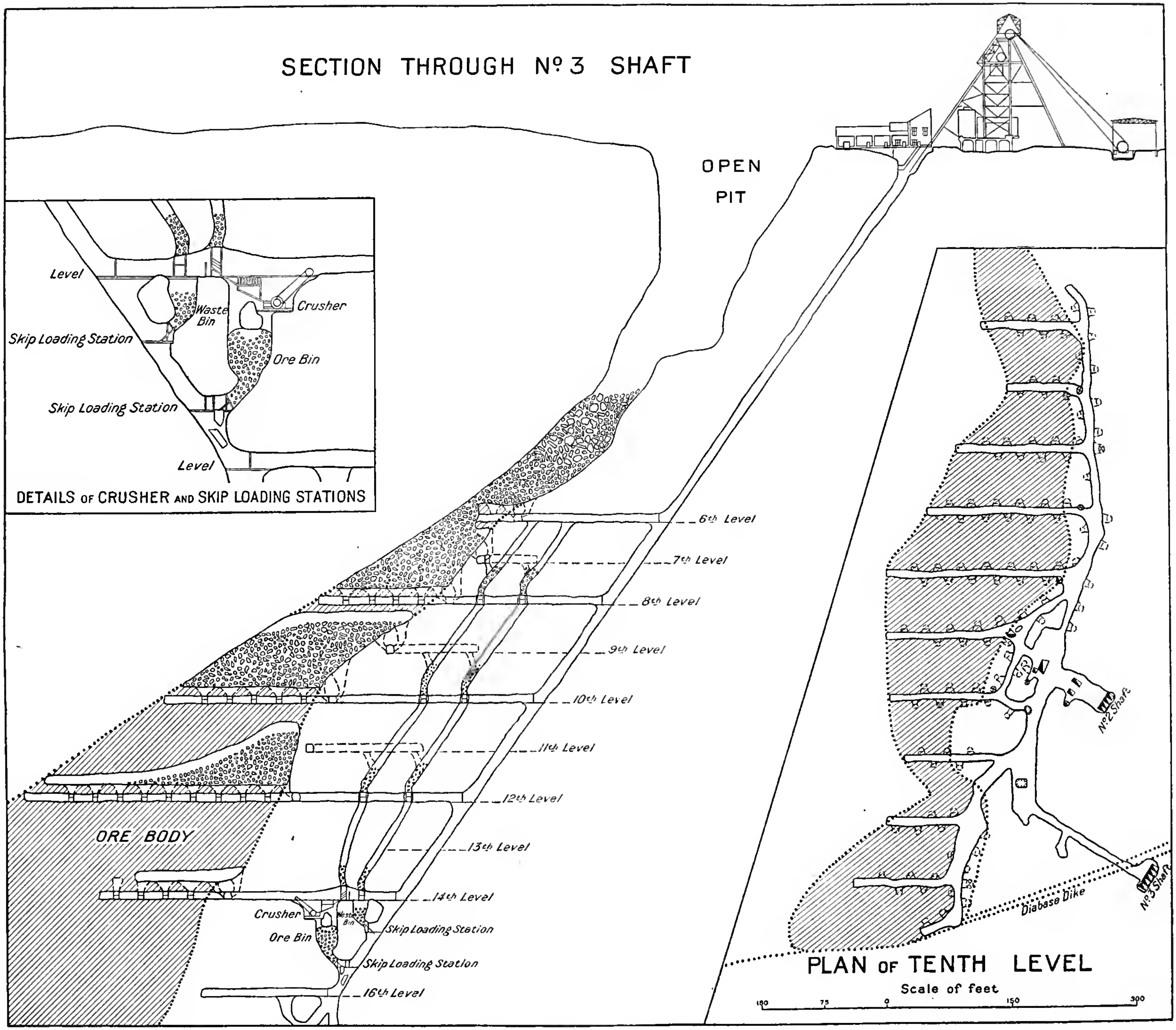
A good deal of construction work was carried on during the year. A hoist house, rock house, combined office and change house, and a steam-heating plant were built. A description of these, furnished by J. C. Nicholls, superintendent of mines, follows.

The No. 3 hoist house is constructed of hollow tile and brick. The floors are of concrete. A forty-ton crane serves the entire building. The interior is well lighted, and will contain nothing but the hoists and accessory equipment.

There will be two hoists, one for ore and one for waste, men and materials. The ore hoist is of the Ilgner type. It has two drums twelve feet in diameter, direct-connected to a 1,800 horsepower direct current motor. Brakes are of the post type, operated by weights and released by cylinders using oil under pressure. The motor generator for the operation of this hoist consists of induction motor, direct current generator and 50-ton flywheel. The hoist, with two skips in balance, will have a capacity of hoisting a load of nine tons of ore from a depth of 2,000 feet at a speed of 2,500 feet per minute.

The second hoist for men and material will be a geared hoist driven by an induction motor through single reduction gears. There will be two drums operating in balance which have a diameter of seven feet. All brakes are of the post type, which are set by weights and released by means of pressure oil. Two cages, each holding thirty men, will be used.

The No. 3 rockhouse was designed to have a capacity of 500 tons per hour,



METHOD OF MINING, CREIOHTON ORE BODY.

but at present it will be run at the rate of only 350 tons per hour. The plant is built in two units, either one of which can be run independently. Each feeder, screen, sorting belt, and crusher is driven by an independent electric motor. The building is made with a concrete base, upon which is erected the steel framework for the rockhouse and headframe. The walls are of hollow tile four inches thick. All floors are of reinforced concrete.

The ore is delivered to the rockhouse from the seven-ton skips, which deliver it into receiving bins. Two revolving feeders pass the ore to a revolving screen having six-inch round holes. The over-size goes to sorting belts where the waste is picked off, and the sorted ore is discharged into a crusher, which reduces the ore to a size suitable for smelting. The undersize from the first screens goes to a second pair of screens having three-inch round holes. The oversize then goes to sorting belts, and after sorting the ore is dropped into the same bin as that from the first sorting belts. The undersize from the second set of screens goes to a third set of screens having one and one-half inch round holes. This then passes to sorting belts, the sorted ore joining that from the previous sorting belts. The undersize from the last set of screens drops into a fine bin. From the bottom of the fine and coarse ore bins, the ore is loaded into railway cars for shipment to the smelter or roast yard.

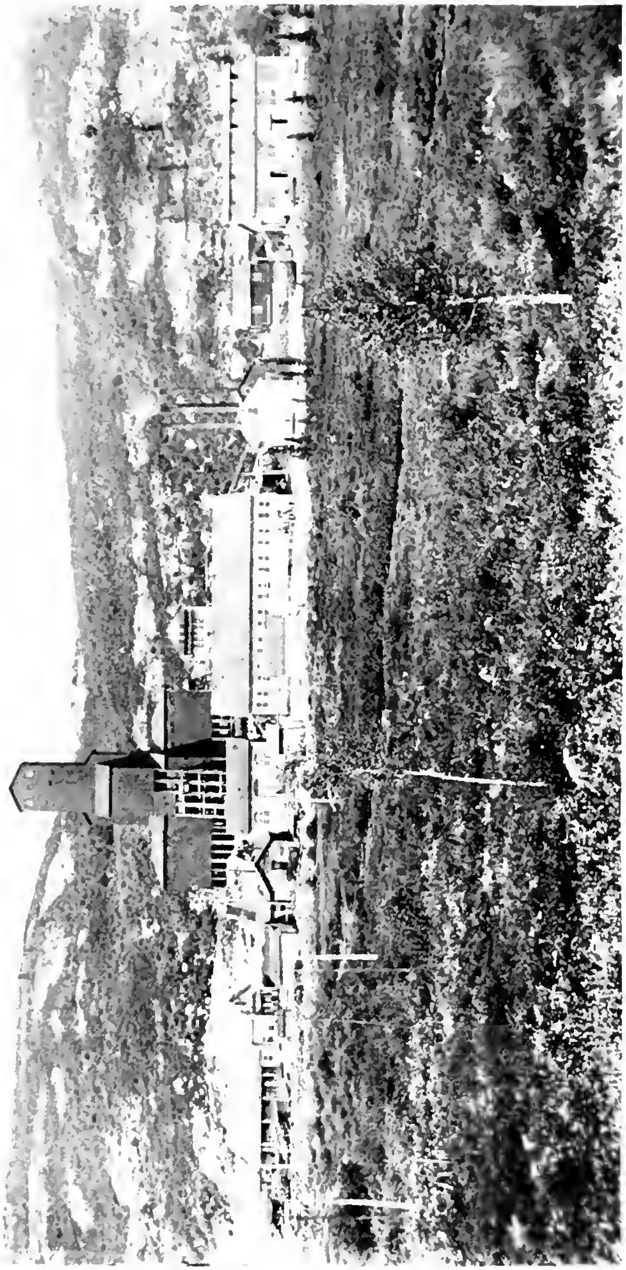
The change house is built to accommodate about 1,100 men. It is constructed with brick walls and reinforced concrete floors, which makes it absolutely fireproof. It is built with two floors, each having the same arrangement. There are tiers of lockers, the lower half of each locker being for street clothes, and the upper half for working clothes. This upper half is connected with a suction fan, which draws the air from the locker and discharges it outside the building. On one side of the building, and running its entire length, is a series of wash basins and shower baths. Each bank of lockers is near a washing place and a shower, so that the men do not have to go more than a few steps, and there is no congestion. After changing, the men pass through the time clocks, then through a covered passage-way to the collar of the shaft, the rockhouse, or the shops.

The office is adjoining the change house and connected with it. The upper floor will be used by the surveyors and draughtsmen. On the lower floor will be offices for the underground superintendent, master mechanic, mine clerk and doctor. There will also be an emergency room for the treatment of injuries.

A central steam-heating plant was erected from which the entire plant is heated. It consists of three one hundred and fifty horsepower horizontal tubular boilers, together with pumps and other accessories.

The steam is conveyed in well covered pipes to the different buildings. In each building is a bank of steam pipes which are heated. Air is drawn by these steam-heated coils by a centrifugal fan and distributed over the building through sheet-metal ducts. The air is thus kept in circulation in a way that is not possible in other systems employing direct radiation only.

In addition to the above, the power house was enlarged and a new 5,000 cubic foot compressor was installed. This compressor is of the Rogler valve type and was



Levack nickel-copper mine, Mond Nickel Company.

built by the Ingersoll-Rand Company. The power house has now a total [illegible] of 12,500 cubic feet of compressed air.

The new underground powder magazine and thaw, described in the Bureau's report of 1915 operations, was put in commission during the year. It is interesting to note that the temperature in the unheated magazine remains very even at about 46 degrees Fahrenheit, even in the coldest weather. Very seldom does any powder need to be thawed, and then only because of freezing in transit from the manufacturers. Polar forcite is used in the cold season, and forcite in the warm.

Fifty-five houses were built in Creighton village in the year.

Charles Miller is superintendent. From 1,200 to 1,300 men were employed.

Mond Nickel Company, Limited

The Mond Nickel Company, Limited, operated the following mines in the Sudbury district, during 1916: Victoria, Garson, Worthington and Levack. A small quartzite quarry was operated, intermittently, near the Coniston smelter. In addition the company operated the old Bruce Mines, situated about thirty miles east of Sault Ste. Marie.

The head offices of the company in Canada are at Coniston. The officials are: C. V. Corless, manager; J. F. Robertson, superintendent of reduction works; O. Hall, mines superintendent.

Bruce.—No. 1 mine, operated through the old number four shaft, began shipments in February, and has been producing steadily since. The greater part of production was from stopes between the third and fourth levels. The ore, a chalcopyrite in a quartz gangue, is shipped direct to the company's smelter at Coniston, where it is used for fluxing purposes. Shortage of labor curtailed both production and development. It is now planned to sink the shaft to the fifth level.

No. 2 mine, known previously as the Taylor shaft, shipped from above the 65-foot level until the end of April. The shaft was then put down to the 155-foot level, and development continued. No. 2 mine lies midway between No. 1 mine and the original Bruce workings near the lake front. These workings will explore a long section on the vein to which little attention had previously been given.

A. D. Carmichael, Bruce Mines, Ont., succeeded J. H. Stovel as superintendent in the month of March. From 60 to 75 men were employed at the two mines.

Levack.—Levack mine shipped about 68,600 tons to the Coniston smelter during 1916. About 30 per cent of the material hoisted is picked out as rock. Stoping was done on the first, second and third levels, but the larger operations were on the third level. Development work on the third level was continuous, and several large stopes, 100 feet between pillars, have now been opened up. During the year 3,228 feet of drifting and cross-cutting, and 1,199 feet of raising, mostly in connection with the third level, was done. The shaft was sunk 112 feet to a depth of 545 feet on the 65-degree incline.

The Nordberg compressor from the Frood Extension mine was set up at Levack in the latter part of the year. This gives, with the two other compressors,

Worthington nickel-copper mine, Mond Nickel Company.

a total capacity of 8,000 cubic feet of compressed air. A new blacksmith shop, 70 feet by 40 feet, was built. The machine shop was also equipped with the necessary machines. This mine has now a complete surface plant, a view of which appears in this report. The change house is a well designed and equipped building.

Thirteen cottages were built in the village, and 13 more were under construction at the end of the year.

F. J. Eager is superintendent; 260 men were employed.

Worthington.—Worthington mine hoisted 172,000 tons of unsorted ore during 1916, from which 77,800 tons of ore was shipped to the Coniston smelter, and this furnished nearly one-third of the metal production of the smelter. The balance of the hoisted tonnage is rock, hand-picked from the ore, and this is crushed and sold to the Canadian Pacific railway for track ballast. Stoping was done on the first and second levels, and one stope was opened up on the third level. Considerable development was done on the third level. The shaft was sunk 165 feet to a depth of 700 feet on the incline or 650 feet vertical. The fourth level station was cut at 650 feet, and 300 feet of drifting done on this level.

Coniston smelter, Mond Nickel Company.

Four cottages were built in the village during the year. Several of the swamps round the village have been drained, cleared, ploughed and fenced, by the company. These will be divided into small garden plots, which will be rented to employees at a nominal figure.

R. N. Palmer is superintendent; about 275 men were employed.

Victoria No. 1.—About 60,000 tons were shipped during 1916. This was obtained from the east ore body on the sixth level and from the west ore body on the ninth, tenth and eleventh levels. The shaft was sunk 300 feet to a depth of 2,625 feet. The twelfth level station was cut at 2,598 feet, and a drift was driven 300 feet towards the ore body.

The ten-foot double drum, motor driven, Nordberg hoist was put in commission early in the year. It is equipped with the latest safety devices.

W. J. Mumford is superintendent. About 135 men were employed.

Victoria nickel-copper mine, Mond Nickel Company.

Garson.—Operations at the Garson mine, last year, consisted mainly in taking out the remnants of old stopes above the fourth level, and in the development of stopes on the sixth level. One thousand feet of drifting was done on the eighth level. The shaft was sunk 150 feet to a depth of 1,020 feet, and stations were cut at the 900- and 1,000-foot levels. The output of 115,000 tons was lower than previous years, due largely to shortage of labour.

The only construction was the remodelling of the machine shop.

From 250 to 350 men were employed. A. L. Sharpe, superintendent for the past eight years, resigned late in December to take a commission in the Tunnellers, of the Canadian Expeditionary Forces. His place was taken by J. R. Thoenen.

Coniston Smelter. Two furnaces and two convertors were operated steadily during 1916. The third furnace and converter were used as spares. Late in the year, alterations were begun in the plant to permit of the addition of two more furnaces and two more convertors. The sintering and flotation concentrating plants were operated continuously. No roasting of the ore in stock piles was done during the summer months. The last pile was lighted late in the winter, and no more were lighted until the fall crops were in. A small quartzite quarry was opened up to supplement the supply of quartz from Bruce Mines.

A permanent safety committee, composed of the department heads of the smelter, was organized in December to act in conjunction with a changing safety committee, chosen from the employees. This committee has been very active in endeavouring to make working conditions as safe as possible, and in trying to educate the employees against the danger of carelessness.

J. F. Robertson is superintendent of all reduction works, E. T. Austin of the smelter, and K. S. Clarke of sintering and concentrating plants.

About 500 men are employed at the smelter and machine shops.

Other Nickel Properties

Howland.—This property, on north half of lot 1 in the second concession of Drury township, was operated by A. D. Carmichael, under lease from the Canadian Nickel Company, Toronto, from August, 1915, to the end of April, 1916. About 800 tons was shipped to the Coniston smelter of The Mond Nickel Company; this ore was said to run from $6\frac{1}{2}$ to 7 per cent. nickel and copper combined. About 75 per cent. of material mined was picked out as rock. The workings consisted of an open pit 23 feet deep, 25 feet wide and 40 feet long.

Mr. Carmichael was in charge and employed about 10 men.

Murray.—The British America Nickel Corporation resumed work at the Murray mine early in August. Work for the balance of the year was confined to unwatering the shaft, timbering and cutting stations in same. The 1,700 cu. ft. electrically driven compressor was removed from the Whistle mine and set up at the Murray. Power has been contracted for to run this compressor, and it is expected that development work will be pushed during the year 1917.

E. Hibbert, Nickelton, Ont., is superintendent of mines for the company. About forty men were employed.

Miscellaneous Mines

Goudreau Pyrite. The Madoc Mining Co., at present controlled by the General Chemical Company of New York, operated their pyrites deposit at Goudreau during the season of navigation. About 67,000 tons were shipped to the works of the General Chemical Company in the United States. The deposit is worked as a steam shovel quarry. The ore is hauled to the mill, where it is crushed and sized before being shipped.

The plant is of steel frame, metal lath and concrete plaster construction. The boiler installation consists of Kieler water tube boilers, Rielly underfeed mechanical stokers, forced draft and a 125-foot brick stack. Bituminous slack coal is used as fuel.

During the year, ten cottages and seven log cabins were erected to accommodate married employees. The company's hotel for employees was burnt down early in the summer, and a new one, now under construction, is nearly completed. It will probably be the finest of its kind in Ontario. The concrete basement contains employees' change quarters, and is fitted with shower baths, lavatories and a well-equipped laundry. The first floor, of hollow tile construction, contains kitchen, dining, reading, lounging and bath rooms. The second floor, also of hollow tile construction, and the third floor, of lumber with asbestos board lining, are divided into fifty-seven bedrooms with bathrooms on each floor. The building has hardwood floors and is steam-heated throughout. Its over-all dimensions are 108 x 85 feet.

J. A. Battle, Jr., Goudreau, is superintendent. About 125 men were employed continuously.

International Copper. The Mt. Ætna Mine, Davis township, was under development for a few months by International Copper, Limited. The company has a capitalization of $150,000. J. E. Boss, Sudbury, is president, and A. J. Mauley, Sudbury, sec.-treas. The old shaft, ninety feet deep, was pumped out and some sinking done. No work was being done at the end of the year.

Massey Copper.—The Sable River Copper Mining Company, Limited, operated the old Massey mine until about the middle of July. It was then shut down, pending a reorganization that would provide funds needed for proper development of the property.

During operations the mine was baled out to below the fourth level, and a small amount of ore stoped out for the mill. A Callow oil flotation unit was installed in the mill, and a run of several months proved that the Massey ore could be successfully concentrated in this way. Jas. J. Flynn, Massey, Ont., was president and manager of the company, and A. E. Hall was superintendent.

The reorganized company, known as the Kenyon Copper Mines, Limited, has a capitalization of a million and a quarter dollars. A. W. McDougal, of Montreal, is president of the new company, and Jas. F. Flynn, Massey, Ont., is a director and the manager.

McDonald Copper.—The McDonald and Jackson property, comprising the greater part of lots 6, 7, 8, 9, and 10, concession V, Gould township, Algoma, was

optioned to Timmins interests in November, 1915. Seven carloads of ore, running from 12 to 17 per cent. copper, were shipped, but the option was thrown up in March, 1916. This property was locally called the Cheney mine, but should not be confused with the Cheney mine mentioned in the 1899 report of the Bureau of Mines, which is on lot 7, concession I, Gould township.

Sudbury Copper. The Sudbury Copper Company, Limited, acquired a copper prospect in Gladstone township, Algoma, and began operations in the latter part of 1916. The company is capitalized at one million dollars. Strachan Johnston, Toronto, is president, and Geo. E. Bent, Iron Bridge, Ont., manager. Sinking has commenced, and it is planned to put up a flotation concentrating mill if development shows up favourably. The small compressor and hoist are run by crude oil engines of the Diesel type.

About 12 men were employed.

Moose Mountain Iron.—Early in May, 1916, A. J. Anderson was made manager of the above company, and work on the property was resumed shortly afterwards.

Prospecting of the ore body, by trenches and diamond drills, blocked out a large tonnage above an adit level. A development cross-cut, on this level, was begun, and the ore was cut early in November. From this cross-cut development drifts will be run, both ways, on the ore. The plans, at present under consideration, are to mine the ore with a series of glory-hole pits along the ore body. The present cross-cut and development drifts will be used as main haulage ways. Five-ton cars, hauled by electric locomotives, will be used, the cars being loaded from chutes at the bottom of the glory-hole pits.

A series of tests has been carried on to determine the best methods of concentration and roasting. Considerable alterations of the flow sheet in the mill have been found necessary, and tests to determine the best crushing arrangements are still being carried out. The concentration of the ore presents no real difficulties. About a thousand tons of concentrates were shipped to United States, to different experimental plants, to ascertain the best methods of roasting. It was found that sintering, by either of the two methods in general use, would roast this ore successfully.

A. J. Anderson, Sellwood, Ont., is general manager. D. R. Thomas was superintendent until end of November, and was succeeded by C. S. Davis. From thirty to forty men were employed.

Long Lake Gold.—The Canadian Exploration Company, Ltd., continued operations on this property until the end of June. The plant was then shut down, as the known ore body had been worked out. Since that time the company have been diamond-drilling in hopes of picking up the ore body below the fault.

R. W. Brigstocke, Naughton, Ont., was superintendent. Prior to shut-down, about 90 men were employed.

Golden Rose.—The Golden Rose Mining Company, Limited, worked a short time during the summer of 1916, on its gold property, situated on the east shore

of Emerald lake, Timagami Forest Reserve. A shaft was sunk to a depth of 30 feet and trenching continued.

Six men were employed by Edward J. Townsend, president and manager of the company.

West Shining Tree and Wasapika Gold Field

An inspection trip was made into this district in September. The following prospects, on which work was being done, were visited.

The Caswell Mining Company, Limited, incorporated in Ontario, $2,000,000 capitalization, F. G. Moller, Buffalo, N.Y., president, and F. A. A. Campbell, Toronto, secretary, was employing 18 men. J. A. Knox, Orillia, was in charge. The crew were employed in stripping and trenching. Sinking was about to begin on a shaft already down fifty feet. Free gold was showing in several quartz veins, and some veins, not showing free gold, had given good assays. The company owned four claims in the township of MacMurchy.

The Burke, Bulloch and Cochrane group of claims were being trenched by the Mining Corporation of Canada, of Cobalt, they having a lease and bond on the property. D. McGavin was in charge, and seven men were employed. The principal vein had been uncovered and sampled over a considerable distance, and a shaft, forty feet deep, had been sunk. Free gold was to be seen on several veins on the property.

Barbara Mines Company, Limited, Geo. R. Rogers, manager, had a small force at work building camps and trenching. The company own seven claims in MacMurchy and Churchill townships. Operations had just been commenced at time of inspection.

The Atlas Mining Company, Limited, A. M. Bilsky, president, had a crew of 12 men trenching the surface of the Jefferson claims. Some very fine free gold showings had been uncovered on this property. Mr. Jefferson was in charge. No sinking had been done.

The above companies are in what is locally called the Wasapika camp.

In West Shining Tree the only active work being done was on the Holden claims. This property, under option to D. Rothchild, of Sudbury, had five men shaft sinking. The vain, ten to twelve feet wide, pans gold freely, and has been uncovered for about 300 feet. D. Clarke was in charge.

The following claims in Wasapika, which were not being worked, but on which development work had been done, were visited.

The Knoxwell Mining Company, owning two claims adjoining the Burke, Bulloch and Cochrane group, had sunk a 40-foot shaft, and had done considerable trenching. Three veins on the property show free gold.

The McVittie and Saville group, lying between the Casswell Mining Company and the Atlas Mining Company, has one shaft down 40 feet and another down 60 feet. The vein has been uncovered across two claims, and shows free gold in several places.

The McIntyre and MacDonald group, lying to the east of the Atlas Mining Company, has one shaft down 20 feet and another down 55 feet. Several veins show free gold.

Gilbert Bennett, owning two claims across the Montreal River from the McIntyre and MacDonald group, has a shaft down 40 feet.

In West Shining Tree the following two claims, not operating, were visited:

The Gosselin Gold Mining Company, Russell Boulby, Toronto, president, own a group of eight claims. There is a large surface showing of quartz, said to carry values. A 40-foot shaft was sunk, and a large amount of stripping done.

Steep, Mitchell and Peddle have a shaft 93 feet deep on claim T.R.S. 2431. This shaft was worked in an unusual way. The partners, having no other means at their disposal, built a whim and operated the same with five sleigh dogs. A heavy inflow of water stopped their work.

Quarries

Bruce Mines.—The Bruce Mines trap rock quarry, W. S. Edwards, Sault Ste Marie, Michigan, trustee, was operated, under contract, by Mitchell and Powell. Crushing was started on May 15th, and operations were continuous until the close of navigation. About 750 tons were crushed and sized daily. Most of product was shipped to the new locks under construction at the American Sault. The balance was shipped to the United States for road-making purposes. E. Mitchell, Bruce Mines, was in charge. About 50 men were employed.

Dominion Mines and Quarries.—The Dominion Mines and Quarries, Limited, operated their quarry on East Neebish island during the season of navigation. The average daily output was about 300 tons, running 98 per cent. silica. The output is shipped to Buffalo, N.Y., where it is used in the manufacture of ferro-silicon. I. Appleton, McLennan P.O., Ont., was in charge. From 40 to 60 men were employed. E. F. Price, New York, is president, and Leighton McCarthy, Toronto, vice-president, of the company, which has its head office in the Dominion Bank Building, Toronto.

Humbug Point.—The Oscar Daniels Company of New York operated a trap rock quarry at Humbug Point, St. Joseph island. Considerable alterations were made to the plant in the early spring, and crushing was begun in May. The quarry was shut down in August, as the company were unable to get boats to handle their product. The output was all shipped to the new locks under construction at the American Sault. The plant is capable of crushing and sizing from 75 to 100 tons per hour. The bin storage, however, is small, and steady operations will depend on transportation facilities. D. Carrol was in charge. About 80 men were employed.

Killarney.—Willmott and Company, of Toronto, operated their quarry, near Killarney, on the northern shore of Georgian Bay, during the season of navigation. From 35,000 to 40,000 tons of quartz, averaging 98 per cent. silica, was shipped to The Electro Metals, Limited, of Welland, where it was used in the manufacture of ferro-silicon. D. Chisholm, Killarney P.O., was in charge. About 40 men were employed.

III.—DISTRICT OF TIMISKAMING

Gold

Boston Creek and Munro Township

Boston Creek.—The Boston Creek Mining Company, Limited, did considerable development work on claim L. 3665 in Boston township during the year. Work was carried on through the R.A.P. shaft, which was rented with hoisting equipment from the R.A.P. syndicate. The drifts on the 100 and 200-foot levels of the R.A.P. were extended into the Boston Creek ground and a raise carried to surface from the 200-foot level. A winze has been sunk 200 feet from the 200-foot level, and stations cut at the 300 and 400. Development is as follows: 100-foot level, 325 feet of drifting and cross-cutting; 200-foot level, 300 feet of drifting and cross-cutting; 300-foot level, 50 feet of drifting and cross-cutting; 400-foot level, 300 feet of drifting and cross-cutting.

In February and March, 1917, new buildings were erected including office, sleep camps, dining room and storehouse. Operations were suspended in July, 1917, to permit of exploration by diamond-drilling. A new central shaft will be located and work resumed in September, 1917.

Air is supplied by two Chicago Pneumatic Tool Company fuel oil compressors.

The officers of the company are: President, E. M. Richardson, New York; vice-president, W. B. Allbright, New York; secretary-treasurer, M. L. Quilliman, Niagara Falls, Ont.; managing director, H. D. Symmes, Niagara Falls, Ont.; mine manager, R. E. Margenau, Boston Creek, Ont.; 50 men were employed up to July, 1917.

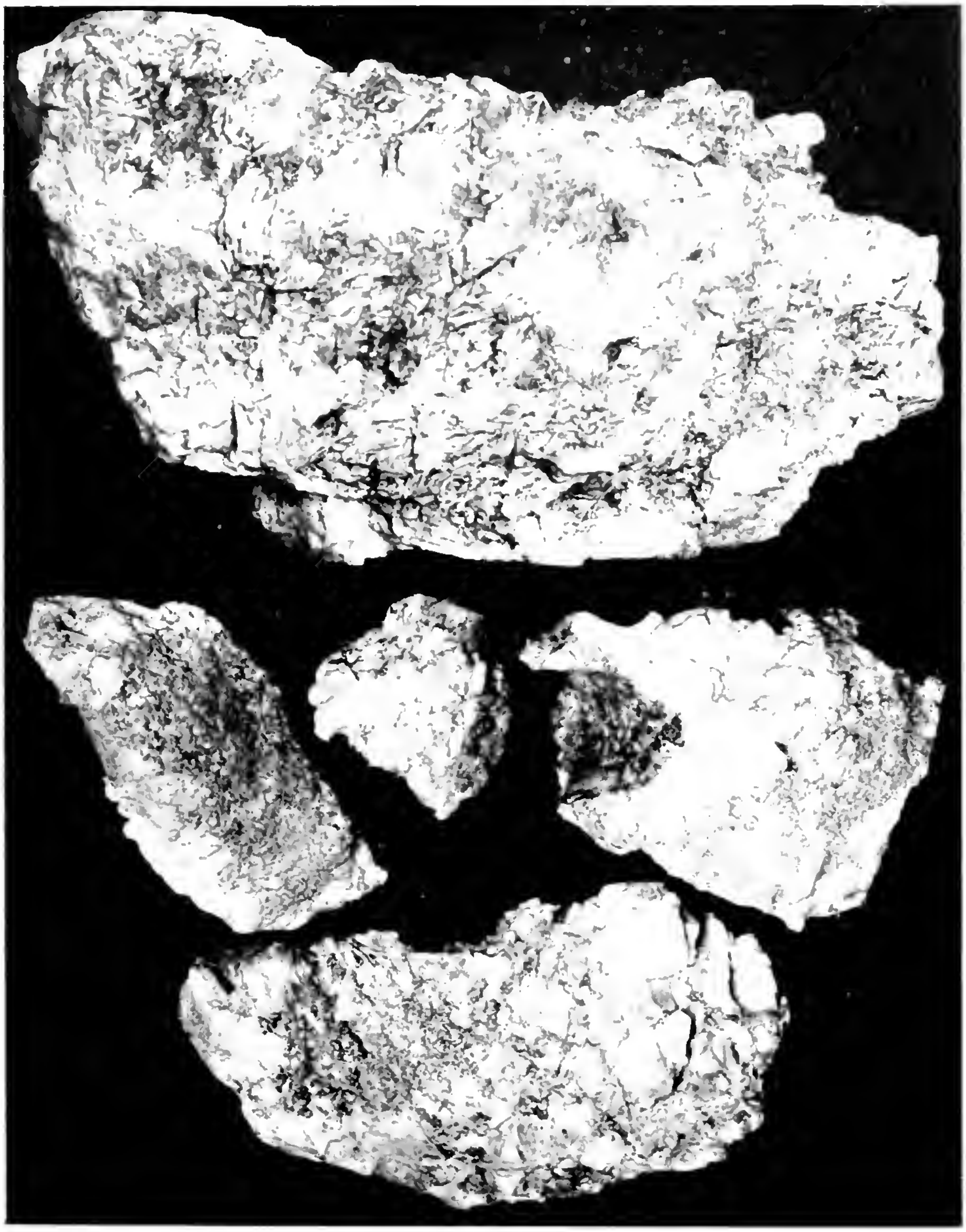
Boston-Hollinger.—This claim, on lot 3 in the sixth concession of Pacaud, was developed during the year by Messrs. Lyman and associates of Cobalt. A shaft was sunk 50 feet, and some drifting done at this level; 17 men were employed.

Boston Gold Leaf Mining Company.—This company did considerable development work on a claim east of the Boston Creek mine, on the boundary of McElroy and Boston townships. Work consisted of trenching and shaft sinking. Two shafts are said to be 40 feet deep, and a third 85 feet deep. Work was discontinued on December 15th, 1916, and in the spring of 1917 the claim was reported sold to the Western Mining Company.

Buffalo-Munro.—The Buffalo-Munro Gold Mines, Limited, worked a short time in 1916, on their claim, part of lot 6 in the first concession of Munro township.

Work was in charge of Wm. Fairbairn, and consisted of trenching and surface development. A shaft was sunk to a depth of 40 feet. Work was discontinued in the fall of 1916, and resumed in April, 1917.

Burton-Munro.—A promising prospect is being developed by the Burton-Munro Mines, Limited, on the north half of lot 11, in the first concession of Munro township. A shaft inclined at 55 degrees, had been sunk to a depth of



Five samples (about one-third actual size) of gold ore from Croesus mine, weighing 85 pounds and containing 180.7 ounces of gold and 47.5 ounces of silver, worth $10,000 approximately. These samples were purchased by the Ontario Bureau of Mines for exhibition purposes. The dark parts in the illustration represent gold. *See* frontispiece for full-size reproduction in natural colours of the right hand central specimen.

150 feet when inspected July 19th, 1917. At the 150-foot level a drift was in progress to the north of the shaft, and on the date of inspection the heading was at 40 feet. It was the intention of the management to discontinue work in this drift, and sink the shaft to the 250-foot level. Very little work was done in 1916 with the exception of 1,000 feet of diamond-drilling, the erection of camps after the fire, and surface trenching.

The officers are: President, Charles Millar, Toronto; secretary-treasurer, A. W. Hunter; directors, Charles A. Gentles, J. G. Beatty, Archie Burton. David Sloan is manager, employing 25 men.

Croesus.—The Croesus Gold Mines, Limited, acquired in 1915 what was locally known as the Dobie-Leyson claim on the north half of lot 10, in the first concession of Munro township. Spectacular gold specimens were found in the shaft, some of which were purchased by the Bureau of Mines and added to the collection of the Bureau. These are exhibited annually at the National Exhibition, Toronto. The disastrous fire of July 29, 1916, destroyed all the buildings and surface equipment of the company, but work was resumed at once and new buildings erected. Development underground during the year 1916 was as follows: the shaft was sunk to the 400-foot level, and stations cut at the 300-and 400-foot levels. On the 150-foot level, drifting 465 feet; on the 200-foot level, drifting and cross-cutting 208 feet, raising 25 feet; on the 250-foot level, drifting 110 feet, cross-cutting 109 feet, raising 60 feet; on the 300-foot level, drifting 61 feet, cross-cutting 200 feet, raising 45 feet; on the 400-foot level, the south cross-cut was advanced 31 feet, and the north cross-cut 61 feet.

In July, 1917, the pumping capacity was found inadequate, and a temporary shut-down occurred until a larger pump could be installed.

A small amount of ore was milled at the Gold Pyramid Mining Company plant before the fire, and early in 1917 the company erected a small mill capable of treating 50 tons per day. The mill equipment includes one Allis-Chalmers jaw crusher, one Robb engine, one Martin 8 by 8 engine, and one Hardinge ball mill, with recovery by plate amalgamation.

The officers are: President, D. M. Steindler, New York; vice-president, Sir Mortimer Davis, Montreal; secretary-treasurer, Eugene L. Steindler, Cobalt; manager, Julius Cohen, Matheson. The head office of the company is 42 Broadway, New York, N.Y.; 10 men were employed during the year.

Miller-Independence.—The Miller-Independence Mines, Limited, worked throughout the year on their property, south half of lot one in the sixth concession of Pacaud township. Considerable development work was done. Shaft A is 76 feet deep with 150 feet of drifting and cross-cutting at the bottom level. Shaft B is vertical to a depth of 20 feet, and from this point follows the dip of the vein to a depth of 120 feet. A third shaft has been sunk on a 30° incline to a depth of 140 feet. On the date of inspection July 17, 1917, preparations were being made to sink shafts C and D.

The Nissen stamps have been replaced by a ball mill, the plate area doubled, and a Groch flotation machine installed; 20 men were employed during the year.

The officers of the company are: President, Geo. J. Miller; secretary, John C. Schaffer, Germantown, Ohio; treasurer, Ed. Rettich, Germantown, Ohio; directors, O. B. Brown, M. Kirkpatrick and John A. Read, all of Dayton, Ohio. M. W. Hotchkin is consulting engineer for the company.

McRae.—The McRae claim is the northeast quarter of the north half of lot 2, in the sixth concession of Pacaud township. Development work was carried on by the Crown Reserve Mining Company of Cobalt, and a shaft sunk 50 feet, during the summer of 1916. Numerous test pits were put down and considerable trenching done by the above company. Work was discontinued in September, 1916.

Peerless.—The Peerless Gold Mines, Limited, own the north half of lot 1 in the sixth concession of Pacaud, adjoining the Miller-Independence.

Camps were built in the fall of 1916, and considerable surface development done; one test pit is 25 feet deep. The chief owners are Messrs. McKinnon and Ogilvie of Montreal, and the work during the year was in charge of Neil Morrison, employing 8 men.

R. A. P.—During 1916, the R. A. P. Syndicate, controlled by Messrs. E. M. Richardson, W. B. Allbright and J. K. Papassimakes, continued development of the Kenzie claim. The shaft was sunk to the 200-foot level and drifting done as follows: On the 100-foot level east drift, 250 feet; west drift, 175 feet; 200-foot level east drift, 90 feet, west drift 190 feet.

The plant includes one 60-h.p. Jenckes locomotive type boiler, and one 5 by 7 Jenckes hoist. Work was discontinued by the syndicate September 17, 1916, and the shaft and hoisting equipment rented to the Boston Creek Mining Company. In July, 1917, preparations were under way to take over the shaft and resume work.

Kirkland Lake Gold Area

Development during 1916 in this area has proven the existence of another gold camp in Ontario of considerable importance. The Northern Ontario Light and Power Company extended its transmission lines from Cobalt to the Kirkland Lake district, a distance of about 70 miles, and is now delivering electric power to the various mines. It is possible that the Timiskaming and Northern Ontario Railway Commission will build a branch line from Swastika.

Elliott-Kirkland.—The Elliott-Kirkland Gold Mines, Limited, own claims L. 1616 and L. 1617 in the township of Teck, and sinking operations were commenced in December, 1916. When last inspected in April, 1917, the shaft was down 105 feet, a head frame was in course of construction, and a small motor-driven compressor and air hoist were installed. S. J. Renaud was in charge, employing 20 men.

Goodfish.—The Goodfish Gold Mines, Limited, own three claims, L. 2194, L. 2022, and L. 2571 in Morrisette township, near the southwestern corner. Prospecting of these claims was continued at intervals during the year and a shaft sunk 30 feet.

The officers of the company are: President, Harry Oakes, Kirkland Lake; vice-president, M. J. Brennan; secretary and manager, J. W. Morrison, Kirkland Lake; treasurer, Wm. Costello; director, Edwin W. Kearney, Haileybury.

Kirkland Lake.—The Beaver Consolidated Mines, Limited, continued development of the claims owned by the Kirkland Lake Gold Mines, Limited, and exercised its option on the stock of the latter by making the first payment on the due date, February 22nd, 1917.

During the year the following development work was performed:—

Drifting, 916.0 feet; cross-cutting, 617.5 feet; shaft sinking, 410.0 feet, total, 1,943.5 feet; station cutting, 149.0 cubic yards, sump cutting, 95.0 cubic yards, total, 244.0 cubic yards. Sinking was still in progress at the close of the year. The vein on which the shaft was sunk from the surface has been proven to the 600-foot level.

The following additions to the plant and surface equipment were made during the year. One 125 h.p. Jenckes boiler, one 10-drill compressor, an electric light plant, a new hoist capable of working to a depth of 900 feet, large bunkhouse and mess-room and office facilities. An assay office is also in course of construction. It is the intention of the management to erect a 100-ton mill during 1917, underground developments having proved satisfactory.

Jay Elliott of the Beaver staff is superintendent, and S. Donaldson is in charge of underground work. Forty men were employed.

La Belle Kirkland.—La Belle Kirkland Mines, Limited, is capitalized at $2,000,000, and owns seven claims in the townships of Teck and Lebel, near the south end of Goodfish lake.

Development was continued chiefly on claim L. 1751, where shaft A had reached a depth of 340 feet, with levels at 100, 270 and 340 feet. On the second level, 1,100 feet of drifting and cross-cutting was done. Diamond-drilling from this level was in progress in the fall of 1916. Shaft B is 55 feet deep, and shaft C 100 feet deep, and on various parts of the property there are test pits and shafts up to 50 feet in depth.

The head office is in the Sterling Bank Building, Fort Erie, Ont. The officers are: President, Dr. Edward J. Meyer; vice-president, Alfred A. Berrick; treasurer, Frederick A. Meyer; secretary, Charles S. Cadwallader, all of Buffalo, N.Y.; general manager, Frank C. Loring, Kirkland Lake P.O.; superintendent, Ernest M. Loring. Thirty men are employed.

Lake Shore.—The Lake Shore Mines, Limited, did very little development work on its claims during 1916. This company owns the following claims in the township of Teck, 2605, 2606, 2645, 2242, 1557, 1663 and 3601.

The mine was closed for four months during the year. It was pumped out in November, and preparations were made for the installation of electrically driven hoist and compressor ready for operation when the power line should be completed.

The shaft is 316 feet deep, with levels at 100, 200 and 300 feet. On the bottom level 750 feet of drifting and cross-cutting was done.

The officers are: President and treasurer, Harry Oakes; secretary [illegible] manager, J. W. Morrison; mine foreman, James McMillan, all of Kirkland Lake, Ontario; 36 men were employed.

Lucky Cross.—Mention is made elsewhere in this report, under the heading Trethewey, of the work done at this mine during 1916 by the Trethewey interests.

Minaker.—The Minaker Gold Mines, Limited, acquired a group of claims to the south of the Lake Shore property. Camps were erected, and a small amount of surface prospecting done in December, 1916. Work was in charge of T. J. Flynn, and it is the intention of the company headed by Frank Mapes of Rochester, N.Y., to push development in 1917.

Sylvanite.—The Sylvanite Gold Mines, Limited, owns the following claims in the township of Teck, adjoining the Tough-Oakes on the west: Nos. L. 2100, 2101, 2102, 2256 and 2257.

On the date of inspection November 18, 1916, six carpenters were employed erecting a head frame, shops and engine room. The shaft was 35 feet deep, and preparations were under way for the active development of the property on the completion of the power line.

The officers of the company are: President, Harry Oakes; secretary, Albert Burt, Toronto; manager, J. W. Morrison.

Teck-Hughes.—During the year the Buffalo Mines, Limited, continued development work of the Teck-Hughes mine and operated the milling plant described in detail in the 25th annual report of the Bureau.

On the date of last inspection, November 17th, 1916, shaft No. 1 was 180 feet deep, and shaft No. 3 located 700 feet west of No. 1, 264 feet deep, and in addition a winze had been sunk 150 feet from the shaft to a depth of 265 feet. Underground development proved satisfactory to the management, both in tonnage exposed and gold content.

The officers are: President, Chas. L. Denison, New York; vice-president, Robt. W. Pomeroy, Buffalo; general superintendent, Thos. R. Jones, Cobalt; superintendent, L. W. Ledyard, Kirkland Lake, Ont.; 36 men were employed.

Tough-Oakes.—The Tough-Oakes Gold Mines, Limited, has an authorized capital of 600,000 shares, par value $5 each.

The development during the year comprised 2,406 feet of drifting, 959 feet of cross-cutting, 351 feet of raising and 437 feet of sinking, or a total of 4,153 feet, bringing the total development to 9,317 feet.

The mill treated 37,263 tons of mine ore and 2,600 tons of tailings, or a total of 39,863 tons, from which was recovered $17.85 per ton.

To December 31st, 1916, the mine had produced 69,574 tons of ore of a gross value of $1,384,808, and ore reserves at that date were estimated to contain $1,000,000.

Four dividends of 12½ cents per share, amounting to a total of $265,750, were paid during the year.

C. A. O'Connell is manager. On an average about 200 men are employed.

Wright-Hargreaves.—The Wright-Hargreaves Mines, Limited, owns the following claims in Teck township adjoining the Tough-Oakes, Burnside and Sylvanite properties: Nos. 708, 709, 710 and 711.

On the last inspection, November 18th, 1916, 25 men were employed, chiefly in construction work, installing plant and erecting buildings, against the completion of the power line from Cobalt. The shaft was 25 feet deep.

Headframe while in course of construction, No. 3 shaft, Dome Mines.

The officers of the company are: President, Oliver Cabana, Jr.; vice-president, Edwin Lang Miller; secretary-treasurer, Gerhard F. Miller; manager, Albert Wende.

Huronia.—La Mine d'Or Huronia, Limited, includes four claims, L. 2586-7 in Gauthier township and L. 2588-9 in McVittie township. The mill was in

operation for part of the year. No. 1 shaft is 102 feet deep with 100 feet of drifting and cross-cutting. The property was shut down on December 2nd, 1916.

Goldfields.—The Associated Goldfields of Larder Lake were in operation during 1916. The main shaft has now reached a depth of 400 feet with considerable drifting and cross-cutting. The 30-stamp mill was idle during the year.

Porcupine Gold Area

Anchorite.—The Coniagas Mines, Limited, developed this property under option during 1916. A small amount of sinking and drifting was done in addition to considerable surface trenching and diamond-drilling. C. E. C. Smith is manager.

Davidson.—The Davidson Gold Mines, Limited, began operations in July, 1916, on the property previously known as the Crown Chartered, on lot 2, in the fifth concession, Tisdale township. The shaft, a vertical two-compartment one, was sunk 100 feet, to a depth of 312 feet, during the year. Three hundred and fifty feet of drifting and cross-cutting, mostly on the 300-foot level, was done. A raise was run from the 100-foot level to the surface. A second shaft, known as the "south shaft," was sunk to a depth of 50 feet.

D. R. Thomas was in charge; 50 men were employed at time of inspection in January, 1917.

Dome.—The Dome Mines Company, Limited, has an authorized capital of $5,000,000, of which $4,000,000 has been issued.

The officers of the company are: J. R. DeLamar, president and treasurer; W. S. Edwards, first vice-president; C. D. Kaeding, second vice-president; H. P. DePencier, third vice-president; Alex. Fasken, secretary; Alfred H. Curtis, assistant secretary and assistant treasurer. The directors are: J. R. DeLamar, W. S. Edwards, Alex. Fasken, G. C. Miller, J. S. Wilson, A. H. Curtis, A. V. Stout. The head office of the company is at 36 Toronto St., Toronto. C. D. Kaeding is general manager.

Four dividends of 5 per cent. each, amounting in all to $800,000, were paid during the year ending March 31st, 1917.

The plant extensions during the year brought the milling capacity up to 45,000 tons a month.

During the year a total of 165,272 tons was mined and hoisted. Of this, 459,530 tons was ore which was sent to the mill and treated, and 5,742 tons was waste which was dumped on the surface. In addition to the above, 157,000 tons of ore was mined and remained in shrinkage stopes. The 459,530 tons of ore treated in the plant yielded bullion worth $2,171,784.83, the average yield per ton being $4.726.

Of the 459,530 tons milled which averaged $5.083; 203,330 tons averaging $3.29 came from the pits, 219,342 tons averaging $6.98 came from the underground stopes, 36,858 tons averaging $3.68 came from the development.

The ore reserves as at April 1st, 1917, are estimated at 2,250,000 tons at $5.32, $11,979,000.

Hollinger Gold Mine, Porcupine.

Summary of Development

For Year Ending March 31st, 1917.

Level	Drifts	Cross-Cuts	Raises	Box Holes	Shafts	Stations	Ore Pockets	Waste Pockets	Total	Diamond Drilling	Grand Total
1st			26						26	294	320
3rd	53	20	313	67					153		453
4th	181		201						382		382
5th	481	54	144	328					1,007	718.5	1,725.5
6th	1,062	410	410.5	313					2,225.5	3,733.1	5,958.6
7th	1,744	251	237	307			73	38	2,650	6,065.0	8,715.0
8th	10					61			74		74.0
Shaft					234				234		234
Surface										612.5	612.5
Totals	3,531	735	1,371.5	1,015	234	61	73	38	7,051.5	11,423.1	18,474.6

A second Bellis and Morcom compressor was completed, and work begun on a third unit of 2,500 cubic feet per minute. New winding engines were installed, a single-drum electric man-hoist, 8-foot diameter drum, geared through single reduction helical gear to 200-h.p. motor, rope speed 800 feet per minute, and one double-drum electric rock-hoist, 7-foot diameter drum, geared through single reduction helical gear to 350-h.p. motor; rope speed 1,000 feet per minute.

A 125-foot steel head-frame and ore bins were completed at No. 3 shaft. A 36 in. by 54 in. underground crusher unit was completed, and the electric haulage put in service.

In the mill, four of the five old tube mills were practically rebuilt, and three Hardinge ball mill units were completed, necessitating the removal of 20 stamps. The regrinding tube-mill circuit was completed, a set of sand-washing cones installed, and another 90-frame slime filter press erected, making five in all.

Dome Lake.—Operating their mill part of the time only, the Dome Lake Mining and Milling Company, Limited, treated 6,540 tons. Changes were made in the mill which now has a crushing capacity of 200 tons daily, and a cyanide capacity of 100 tons daily. Considerable underground development was done. R. T. Regnell is manager. About 60 men were employed.

Hayden.—The Hayden Gold Mines, Limited, continued development of its property in Ogden township during 1916. The shaft was sunk 216 feet to a depth of 318 feet, and 235 feet of drifting was done. The shaft is vertical and the property is being developed on the 100-foot, 200-foot and 300-foot levels.

Wm. Shovel is superintendent. About 16 men were employed.

Hollinger.—The Hollinger Consolidated Gold Mines, Limited, has an authorized capital of 5,000,000 shares of $5 par value each.

The officers of the company are: President, Noah A. Timmins, Montreal; vice-president, John McMartin, Cornwall; secretary-treasurer, David A. Dunlap, Toronto; managing director, P. A. Robbins, Timmins; directors, Noah A. Timmins, L. H. Timmins, John B. Holden, John McMartin, David A. Dunlap and P. A. Robbins; head office, 85 Bay St., Toronto.

During the year 1916, 601,062 tons of ore were hoisted containing $5,312,000; $3,126,000 was paid in dividends; $1,223,132 was paid out for labour and $951,300 for stores. The total costs, including taxes and depreciation, amounted to $4.03 per ton of ore milled.

Expenditure for plant and equipment amounted to $599,417.16.

Mine development amounted to 20,280 feet as follows:

Level	Shafts	Drifts	Cross Cuts	Raises	Winzes	Diamond Drilling	Timbering. Shafts & Winzes	Timbering. Stopes
	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
100 feet		70		48				237
200 feet	239	2,695	1,074	297		1,128	166	2,146
300 feet	202	1,895	2,522	167		433	214	2,011
425 feet	281	2,908	2,262	1,394		788	251	2,062
550 feet	25	1,384	111			190	6	777
675 feet		424	124	10				
800 feet	32	1,124	1,626			695		
1,100 feet					121		120	
1,250 feet		171	60		14	196	18	
	779	10,671	7,779	1,916	135	3,430	775	7,233

The stoping record for the year is shown in the following table:

Level	Broken Ore in Stopes Jan. 1, 1916	Ore Broken during 1916	Ore Removed during 1916	Broken Ore in Stopes Dec. 31, 1916.
	Tons	Tons	Tons	Tons
100 feet	1,850	20,655	18,214	4,291
200 feet	74,500	203,947	205,525	72,922
300 feet	36,360	134,047	133,744	36,663
425 feet	24,600	185,381	127,288	82,713
550 feet	500	28,820	18,730	10,590
675 feet		729	729	
800 feet		28	28	
	137,810	573,607	504,258	207,179

The company makes the following statements as its ore reserves:

—	Tons	Value Per Ton	Estimated Gross Value Dec. 31, 1916	Estimated at Dec. 31, 1915
		$ c.	$	$
No. 1 Vein	325,190	11 19	3,639,170	4,946,500
No. 2 Vein (North)	64,690	14 62	946,030	1,844,500
No. 2 Vein (South)	97,070	7 64	741,700	1,070,500
No. 3 Vein	18,000	5 10	91,920	113,000
No. 4 and 50 Veins	613,140	8 25	5,059,480	6,220,550
No. 5 Vein	32,540	10 00	325,400	753,280
No. 7 Vein	17,000	10 47	178,000	178,000
No. 8, 38 and 53 Veins	637,890	7 60	4,849,340	3,820,230
No. 10 Vein	25,400	7 35	186,800	186,800
No. 13 Vein	37,000	5 54	205,000	137,400

—	Tons	Value Per Ton	Estimated Gross Value Dec. 31, 1916	Estimated at Dec. 31, 1915
		$ c.	$	$
No. 14 Vein	162,080	8 81	1,427,170	1,728,920
No. 15 Vein	65,010	10 19	662,830	267,200
No. 16 Vein	7,040	7 40	52,100	296,600
No. 26 Vein	24,860	9 33	231,980	....
No. 37 Vein	20,750	8 45	175,440	292,700
No. 41 Vein	317,730	7 32	2,326,130	2,184,820
No. 44 Vein	8,000	20 00	160,000	160,000
No. 51 Vein	14,600	6 36	92,900	92,900
No. 52 and 52A Veins..	86,460	10 09	872,260	479,630
No. 54 Vein	122,260	7 21	881,540	1,037,170
No. 55 Vein	47,570	13 13	624,680	....
No. 56 Vein	88,210	6 07	535,670	213,770
No. 58 Vein	276,000	8 96	2,472,610	1,502,730
No. 59 Vein	57,970	10 84	628,690	628,690
No. 65 Vein	49,300	12 47	614,760	614,760
No. 74 Vein	14,000	4 21	59,000	59,000
No. 79 Vein	17,730	5 52	97,800	97,800
No. 83 Vein	24,780	5 79	143,660	143,660
No. 84 Vein	99,120	7 01	695,110	39,620
No. 85 Vein	217,540	7 75	1,687,040	1,199,840
No. 88 Vein	2,970	14 74	43,800	43,800
No. 200 Vein	3,300	18 77	61,950	61,950
No. 204 Vein	5,920	6 40	37,890	37,890
No. 206 Vein	7,360	6 95	51,160	51,160
No. 207 Vein	42,000	6 00	252,000	252,000
No. 226 Vein	12,180	30 37	370,000	....
Surface................	275,880	9 80	2,704,255	2,780,500
	3,938,540	$8 68	$34,185,525	$33,837,870

In connection with the above summary of ore reserves the managing director, P. A. Robbins, makes the following remarks in the company's printed report for 1916:

Ore reserves have been estimated upon the same basis as previously, although they are somewhat more conservative in that certain doubtful valuations have been eliminated. In spite of greatly curtailed development, we still show approximately the same reserves as we did in last year's report, and during the interval there has been removed from the mine 604,062 tons, containing $5,342,234.77, an average of $8.84 per ton.

In estimating the reserves we use the actual measurements of the ore in place, but when the ore is mined it is not possible to prevent a certain amount of waste rock from being broken and becoming intermingled with the ore. This dilution with waste has the effect of lowering the value per ton of the mixture, although it increases the number of tons. Our experience, after five years of operations, has been that there is a dilution of approximately 10 per cent., and hence the present estimate of 3,938,540 tons at $8.68 per ton will when milled probably yield approximately 4,300,000 tons, averaging about $7.75 per ton.

It gives me pleasure to report that all of our underground developments have been highly favorable, and once normal conditions of labor are restored there can be no doubt but that developments will continue to show increases in total values of ore beyond those contained in the present estimates.

Maidens-Macdonald.—This property on claim M.R. 826, Deloro township, was developed, under option, by the La Rose Mines, Limited, of Cobalt.

No. 1 shaft, vertical, was sunk 107 feet. No. 2 shaft, inclined at 65 degrees, was sunk 100 feet. It was planned to join these shafts by a drift on the 100-foot level, and some drifting was done. The option was thrown up in March, 1917.

G. C. Bateman was manager, and about 20 men were employed

McEnaney.—The Hollinger Reserve, on lots 2 and 3, in the fifth concession of Ogden township, now known as the McEnaney Gold Mines, was re-opened in September of 1916. The mine was pumped out in January, 1917. It is developed to the 200-foot level by a vertical two-compartment shaft. An inclined winze runs from the 200-foot to the 300-foot level. Five hundred and fifty feet of drifting and cross-cutting had been done by the former company on the 100-foot level; 2,180 feet on the 200-foot level, and 650 feet on the 300-foot level. At the time of inspection in January, 1917, 18 men were employed and William M. Sixt was manager. Bernard McEnaney is owner and operator of the property.

McIntyre.—On January 1st, 1917, the assets of the McIntyre Jupiter and McIntyre Extension companies were amalgamated with those of the McIntyre Porcupine Mines, Limited, and the combined properties are now operated by the McIntyre Porcupine Mines, Limited. The capitalization was increased from 3,000,000 to 4,000,000 shares of $1 par value each. Of this amount, 3,600,000 shares have been issued and the balance remains in the treasury as unsold shares. The following development work was done during the 15 months' period from April 1st, 1916, to June 30th, 1917, chiefly in No. 5 shaft and McIntyre Extension shaft on the north shore of Pearl lake:

Station cutting	210	feet.
Shaft sinking	689	"
Drifting	3,307	"
Cross-cutting	1,409	"
Raising	897	"
Diamond drilling	5,300	"

The total lateral and vertical development in all the properties to June 30th, 1917, was 44,997 feet. No. 5 shaft is now 1,000 feet deep, with levels at every 100 feet.

The McIntyre Extension shaft, formerly known as the Pearl Lake shaft, is connected on the 1,000-foot level with No. 5 workings and drifting is in progress to connect with the Jupiter, a distance of 2,300 feet. The Jupiter shaft is 680 feet deep, with sinking in progress to the 1,000-foot level.

When this development is completed, all the ore from the three workings will be delivered to pockets at the 1,000-foot station of the Extension shaft, which will become the main hoisting shaft of the workings north of Pearl lake.

At this shaft a new electrically operated Jenckes hoist has been installed; also a No. 7½ Gates crusher followed by a set of 54 inch by 24 inch rolls. From the rolls the ore is delivered to the pockets by a belt conveyor, and to the mill on the south shore of the lake by an aerial tram with a capacity of 75 tons per hour. The ore from the Jupiter shaft is hauled on a narrow gauge track to the rock house at No. 5 shaft. This will be done away with when the underground development as mentioned above is completed.

A new transformer house has been erected during the year near the main shaft, and 3-600 k.va. transformers installed. The air capacity has been increased by the installation at the main shaft of one Ingersoll Rand direct-connected compressor, capacity 3,000 feet per minute.

A new dry house has been planned, and ultimately the warehouse and all

the shops will be centrally located in the area between No. 5 shaft and the main shaft on the north shore. During the 15 month period ending June 30th, 1917, the mill treated 195,327 tons of ore with a gold production of $1,861,911.28, representing an average value per ton milled of $9.517. A fourth unit "D" of 150 tons has been added to the mill, which has now a capacity of 600 tons per day.

The ore reserves were greatly increased during the year.

The officers of the new company are as follows: President, J. P. Bickell, Toronto; vice-president, Sir Henry M. Pellatt, Toronto; secretary-treasurer, M. P. Van der Voort, Toronto; directors, W. J. Shepard, Waubaushene; J. B. Tudhope, Orillia; E. F. B. Johnston, Toronto; H. D. Symmes, Niagara Falls; general manager, R. J. Ennis, Schumacher; mine superintendent, J. E. McAllister; mill superintendent, A. Dorfman. An average of 320 men was employed during the year.

Newray.—The Newray Mines, Limited, began operations on the Rea property, in Tisdale township, in July, 1916. Surface trenching and diamond-drilling was done in 1916. Mine de-watering was begun in December, and completed January 15th, 1917. A 1,000-foot cross-cut is to be driven on the 400-foot level.

The capitalization of the company is $1,500,000. Dr. Bixby, Buffalo, N.Y., is president, and James E. Day, Toronto, is secretary. C. P. Charlebois is manager. About 25 men were employed.

Porcupine Crown.—The Porcupine Crown Mines, Limited, has an authorized capital of 2,000,000 shares of a par value of $1 each. The officers of the company are: John W. Carson, president; W. I. Gear, 1st vice-president; J. G. Ross, 2nd vice-president; James Cooper, secretary and treasurer. The directors are: John W. Carson, W. I. Gear, J. G. Ross, C. A. Smart, J. W. Ross, A. G. Gardner, R. W. Reford, F. S. Meighen, Z. Gallagher, James Cooper. S. W. Cohen is general manager and M. W. Summerhayes manager.

During the year, 1916, 51,273 tons of ore were milled of an average value of $11.78. The net value of the production after deducting mint charges was $571,652.50; 1,753 feet of development and 1,156 feet of diamond-drilling was done during the year.

The ore reserves are given in the annual report as 97,000 tons of a value of $1,050,000. Dividends paid during the year amounted to $240,000, bringing the total dividends to $720,000.

Premier.—This property on lot 6 in the sixth concession of Deloro township, previously known as the Standard Gold Mines, was taken over by the Porcupine Premier Gold Mines, Limited, in January, 1916. Work done during the year comprised 378 feet of drifting, 10 feet of raising and 50 feet of sinking. When inspected in January, 1917, sinking to the 200-foot level was in progress.

George W. Fields, 19 Congress Street, Boston, is president of the company, which is capitalized at $1,000,000. B. M. Walton is superintendent; 14 men were employed.

Porcupine-Vipond-North Thompson.—The holdings of the North Thompson Associated Gold Mines were amalgamated on December 15th, 1916, with those

of the Vipond Gold Mines, and a new company formed known as the Porcupine V. N. T. Gold Mines, Limited.

Development during the calendar year 1916 at the North Thompson mine was as follows: The 3-compartment shaft was sunk to the 600-foot level and stations cut at the 50-100-200-300-400-500 and 600-foot levels; 2,000 feet of drifting and cross-cutting were done chiefly at the 400-500 and 600-foot levels. On the bottom level a cross-cut had been driven from the station a distance of 100 feet to the northwest and the vein drifted on for 50 feet. An incline tramway has been erected from the North Thompson shaft to the Vipond mill. It is the intention of the management to connect with the Vipond workings underground by drifting on the 600-foot level.

At the Vipond mine the main shaft was sunk from the 300 to the 400-foot level and a winze sunk from the 400 to the 500-foot level. On the 400 and 500-foot levels 1,000 feet of drifting and cross-cutting were done during the year, in the general direction of the North Thompson workings. About 2,000 feet of diamond-drilling were done on the property during the year.

The ore mined amounted to 43,011 tons, from which was recovered 12,508.9 Troy ounces of gold bullion. This yielded 8,508.7 fine ounces of gold and 1,255.0 ounces of silver. The average tonnage treated per calendar month was 3,681 tons.

The costs for the year were as follows:—

Average milling costs	$1.13 per ton.
Average mining costs	2.31 " "
General costs	.29 " "
Total costs at mine	$3.73 per ton.

The milling practice remains the same as last report. The ore is first crushed in a 16 by 10 jaw crusher, Blake type, and elevated to bins. It is then crushed in one 6-foot and one 4½-foot Hardinge ball mill, followed by two Hardinge pebble mills. It then enters a closed Dorr classifier circuit, cyaniding by the continuous counter-current decantation method, through Merrill presses, with precipitation by zinc. The boiler and compressor plant will be moved from the Vipond to the North Thompson. A new electrically driven Ingersoll Rand, two-stage compressor, capacity 1,050 feet, was installed at the Thompson during the year, which gives, with the Vipond plant, an air capacity of 2,500 feet.

The officers of the company are: President, H. H. Ward, New York; 1st vice-president, F. H. Hamilton, London, England; 2nd vice-president, P. N. Furber, London, England; secretary-treasurer, R. J. Ward, New York; directors, R. T. Shillington, Haileybury; James J. Hill, St. Paul; D. I. Jackson, Sir Henry M. Pellatt, Toronto; the head office is 50 East 42nd St., New York. The general manager is N. J. Evered, Box 189, Timmins.

Schumacher.—The Schumacher Gold Mines, Limited, has an authorized capital of 2,000,000 shares of a par value of $1.

The officers of the company are: F. W. Schumacher, president; F. L. Culver, vice-president; Earl S. Davis, treasurer; F. A. Hammond, secretary. The directors are: F. W. Schumacher, H. E. Tremain, Jas. Y. Murdoch, O. C. Manly and F. L. Culver. The head office is at 85 Bay St., Toronto.

The following information is taken from the second annual report of the company, covering the operations for the nine months ending March 31st, 1917.

The mill treated 35,271 tons of an average value of $5.24.

The following work was accomplished during the nine months' period:

Main Shaft—

Level	Sinking	Drifting	Cross-cutting	Raising	Diamond-drilling
100-foot	....	813.6 ft.	179.2 ft.	36.0 ft.	270.0 ft.
200-foot	....	411.8 ft.	424.8 ft.	14.5 ft.	333.5 ft.
300-foot	....	128.9 ft.	101.0 ft.	....	916.5 ft.
400-foot	....	146.0 ft.	....	38.5 ft.	160.0 ft.
600-foot	....	66.6 ft.	....	....	62.0 ft.
	....	1,566.9 ft.	705.0 ft.	89.0 ft.	1,742.0 ft.

No. 4 Shaft—

200-foot	185.0 ft.	31.0 ft.	200.0 ft.	....	509.0 ft.
	185.0 ft.	1,597.9 ft.	905.0 ft.	89.0 ft.	2,251.0 ft.

Stoping—

Level	Broken Ore in Stopes June 30, 1916	Ore Broken July 1, 1916, to March 31, 1917	Ore Removed July 1, 1916, to March 31, 1917	Broken Ore in Stopes March 31, 1917
100-foot	3,500 tons	9,835 tons	10,204 tons	3,100 tons
200-foot	1,500 "	8,420 "	9,339 "	600 "
300-foot	600 "	7,100 "	6,749 "	950 "
400-foot	....	6,374 "	4,287 "	2,100 "
	5,600 tons	31,729 tons	30,579 tons	6,750 tons

In addition to the above 1,596 tons of waste were hoisted from development work.

Ore reserves are estimated by the management as follows:

Main Shaft—

Above 100-foot Level	20,980 tons	valued at	$157,550 00
Above 200-foot Level	30,945 tons	valued at	210,540 00
Above 300-foot Level	18,700 tons	valued at	109,100 00
Above 400-foot Level	9,750 tons	valued at	45,050 00
Above 600-foot Level	4,000 tons	valued at	16,000 00
	84,375 tons	valued at	$538,240 00

No. 4 Shaft—

Above 200-foot Level	5,000 tons	valued at	81,500 00
	89,375 tons	valued at	$619,740 00

Tommy Burns.—The Tommy Burns Gold Mines, Limited, did a small amount of work on its property in the southeast corner of Shaw township. One shaft is down 40 feet, and another 25 feet. Wm. Hatch is manager.

West Dome.—The West Dome Consolidated Mines, Limited, resumed operations on the West Dome property in March, 1916. The shaft, inclined at 62 degrees, was sunk 260 feet during the year. It is now 350 feet on the incline, with levels at 100 and 300-foot vertical depths. Nine hundred feet of drifting and crosscutting was done, mostly on the 300-foot level.

The capitalization of the company is $3,000,000. Sir H. M. Pellatt, of Toronto, is president. C. H. Menaton, Traders Bank Building, Toronto, is secretary. W. J. Trethewey is manager; 35 men were employed.

Slade-Forbes Asbestos.—An interesting development in the Porcupine district during the latter part of 1916, was the opening up of an asbestos deposit in the southeast portion of Deloro township by Messrs. Edward Slade and J. M. Forbes of Montreal.

Actual mining was started on January 10th, 1917, and a ton of hand-cobbed, No. 2 asbestos was shipped as a trial lot on January 19th. This pit when inspected on January 18th, was 25 feet long, 15 feet wide and 10 feet deep.

Messrs. Slade and Forbes, who had previously operated in the Thetford district of Quebec, stated that the deposit contained a higher percentage of crude, though of a somewhat inferior quality, than those in the Thetford district. As the property was taken up after the snow fell, the full extent of the deposit was not known, but it is said to be at least 100 feet wide; 12 men were employed.

Alexo Nickel.—During 1916 the Alexo Mining Company, Limited, shipped 8,288 tons of nickel ore, of nearly 5 per cent. grade, to the Coniston smelter of the Mond Nickel Company, Limited. The shaft was sunk 110 feet to a depth of 185 feet. A second level was cut at 120 feet, and some development done on this level on the east side. The west side of second level was previously worked from a winze. Wm. Anderson is manager; 20 men were employed.

Silver Mines of Cobalt and Vicinity

Adanac.—The Adanac Silver Mines, Limited, continued development on its property in the southeastern part of Coleman township, formerly known as the Pan-Silver.

Work was confined to the Patterson shaft, which was sunk to a depth of 408 feet with station at 392 feet.

The west winze was sunk 110 feet and 122 feet of drifting done. The east winze was sunk to the 121-foot level with a sub-level at 77 feet. A total of 248 feet of drifting and cross-cutting was done on this sub-level, also 151 feet of drifting at the winze bottom.

In the course of the development several calcite veins and stringers showing ruby, smaltite and some native silver have been encountered.

During the year 10 men were employed by the contractors, Purdy Bros., under superintendent George Randolph, Cobalt.

The officers of the company are: President, R. A. Cartwright; vice-president, E. N. Campbell; treasurer and managing director, Morgan R. Cartwright; secretary, E. M. Boyd; directors: R. A. Cartwright, E. N. Campbell, M. R. Cartwright, C. N. Bushnell, A. B. Hind.

Aladdin. The Chambers-Ferland mine was operated during 1916 by the Aladdin Cobalt Mining Company, Limited.

Work was confined to No. 1 shaft west of the railway, and practically to the 125-foot and 350-foot levels. Most of the ore produced came from veins 18, 15 and 64, and early in 1917 development 100 feet north of 64 vein was continued by sinking No. 1 winze, in No. 24 cross-cut.

The ore was milled at the Northern Customs concentrator.

The officers of the company are: President, Major Conrad Jorgenson; secretary-treasurer, F. F. Fuller; directors, Major Charles Gold, Dennis Herbert, H. B. Sedgwick, all of London, England. The Canadian advisory board consists of R. T. Shillington, C. A. Richardson and Arthur Ferland, all of Haileybury, with Alex. Fasken of Toronto, secretary.

J. A. McVichie, Cobalt, is manager. About 50 men were employed during the year.

Beaver. The Beaver Consolidated Mines, Limited, have an authorized capital of 2,000,000 shares of a par value of $1. The officers of the company are: F. L. Culver, president and general manager; F. C. Finkenstaedt, vice-president; H. E. Tremain, secretary-treasurer. The directors are: F. C. Finkenstaedt, F. L. Culver, F. L. Lovelace, W. Thos. Mason, W. E. Stevenson, H. E. Tremain, J. H. Black. The head office is at the Lumsden Building, Toronto. The mines are at Cobalt, Elk Lake and Kirkland Lake.

The work done at the Beaver mine, Cobalt, during the year is shown in the following table:

Drifting	3,115.0 feet
Cross-cutting	2,174.0 "
Sinking	229.0 "
Raising	1,101.9 "
Total	6,619.9 "
Stoping	6,512.2 cubic yards.
Station cutting	34.0 " "

Regarding the development on the 1,600-foot level the annual report of the company makes the following statement:

On this level a very interesting development has taken place during the past year. After completing our station, cross-cuts were driven both east and west of the shaft, and a number of veins encountered, some of which have given small silver values. In No. 1 cross-cut two large quartz veins were cut, one of which has been drifted on for quite a distance without encountering any silver values. In No. 2 cross-cut to the west a large vein of from six to eight inches in width was recently cut. This vein showed native silver, and leaf silver is scattered through the wall rock for a distance of about four feet on both sides of the vein. A short distance farther on another vein was encountered, but from the direction of these veins, it would appear as though they would soon join. The character of the veins, where cut, and the general condition of the formation, leads us to believe that we are probably on the top of an ore body, consequently a station has been cut and we are preparing to sink a winze to prove the ground at this point.

We might mention that, as the general character of the formation of the ground along the lower contact does not correspond with that of the upper contact, the work on the upper levels of the mine does not serve as any guide in the development of the lower contact.

The total production for the year amounted to 566,961 ounces of silver. The mill treated 34,766 tons of ore.

One dividend of $60,000 was paid during the year.

The Beaver Auxiliary property was not worked during the year.

In the Kirkland Lake district the company exercised its option on the stock of the Kirkland Lake Gold Mining Company, which own 362 acres in that section. Work was confined to the McKane claim. The shaft was continued to the 500-foot level, and levels opened up at 100, 200, 300, 400 and 500 feet, and $350,000 worth of ore put in sight. Following is a summary of the development:

Drifting	916.0	feet.
Cross-cutting	617.5	"
Shaft sinking	410.0	"
Total	1,943.5	"
Station cutting	149.0	cubic yards.
Sump cutting	95.0	" "
Total	244.0	" "

A 125-h.p. boiler, 10-drill compressor and hoist have been installed in addition to the original plant.

Buffalo.—The following information is taken from the eleventh annual report of the Buffalo Mines, Limited, covering operations for the year ending April 30th, 1917.

The work performed underground was as follows:—

—	Raising	Drifting	Stoping
1st level	60 feet	1,150 feet	120,800 cu. ft.
2nd level	90 "	455 "	76,000 "
3rd level	90 "	75 "	27,100 "
Totals	240 feet	1,680 feet	223,900 cu. ft.

Totals to date are:

Shaft sinking	2,249	feet.
Drifting	20,166	"
Stoping	2,881,442	cu. ft.

During the year total ore tonnage broken was 25,258, of which 3,108 tons was waste rock used for filling. Of the balance 14,452 tons was hoisted to the mill, and 7,698 tons was added to reserves of broken ore in the stopes.

The mill treated 14,452 tons from the mine by combination concentration and oil flotation, and 35,507 tons of sand tailings by flotation methods. There were recovered in jig and table concentrates 207,174 ozs. silver and in flotation concentrates 117,462 ozs. making a total of 324,636 ozs.

The cyanide plant treated 3,038 tons of slimes and middlings from concentrator and flotation plant, with a recovery of 32,383 ozs. The tailings from cyanide plant were then treated by flotation and a further recovery made of 4,706 ozs.; total 37,089 ozs.

The total production of silver for the year from all processes, including concentrate on hand and at smelters, amounted to 391,587 ozs.

Only a portion of the concentrates produced by oil flotation have been treated and turned into bullion. The delay in the completion of the Holt-Dern installation for roasting these concentrates and the erection of a leaching plant, caused a large accumulation of flotation concentrates at the high-grade plant awaiting treatment.

Mention is made elsewhere in this report of the Holt-Dern roasting furnace.

There yet remain to be treated approximately 275,000 tons of sand tailings, containing 1,400,000 ozs. also 3,000 tons residues at the high-grade plant.

The officers and directors are: President, Charles L. Denison, New York, N.Y.; vice-president, Robt. W. Pomeroy, Buffalo, N.Y.; 2nd vice-president, Harland B. Crandall, New York; secretary and treasurer, George C. Miller, Buffalo; director, Albert W. Johnston, New York.

Mr. Tom R. Jones, Cobalt, is general superintendent.

Calumet and Montana.—Work by the Calumet and Montana Consolidated Mining Company, Limited, was commenced in September, 1915, on the property in Coleman township known as the Cyril Lake or Airgoid. This claim adjoins the Dominion mine, formerly known as the Nova Scotia mine, owned by the Dominion Reduction company.

Work during 1916 was devoted entirely to development above the 90-foot level. The shaft is 225 feet deep with first level at 50 feet and second at 90 feet. On the date of last inspection, February 23rd, 1917, the heading on the east drift, 1st level was at 116 feet, and the north drift on 2nd level had reached 352 feet.

Nine men were employed under superintendent J. S. Clarke, of Cobalt.

The officers of the company are: President, H. O. Oswald, Minneapolis, Minn.; secretary-treasurer, Charles Bilby, Toronto; directors, C. V. Patterson, St. Paul; W. W. Sloan, Toronto; W. G. Weichel, M.P., Waterloo, Ont.; and manager G. G. Thomas, Box 227, Cobalt.

Casey-Cobalt.—The Casey-Cobalt Silver Mining Company, Limited, continued active development and production at its mine in Casey township, up to the disastrous bush fire August 22nd, 1916, which completely destroyed the surface plant, buildings and equipment. The remainder of the year was spent in rebuilding, and the management had to face the largely increased cost of material and the slow deliveries due to war conditions.

Considerable exploration and development has been done on this property. There are six shafts as follows:

No. 1—242 feet deep, plus 50 foot winze.
No. 2—test pit only.
No. 3—282 feet deep.
No. 4—147 feet deep.
No. 5—50 feet deep.
No. 6—371 feet deep, plus 50 foot winze.

With the exception of 600 feet of diamond-drilling in No. 3 workings, all work during 1916 was done at No. 6 Shaft. At No. 6 the following progress was made before the fire.

Stoping	111,852 cu. ft.
Drifting	1,183 feet.
Cross-cutting	912 "
Winzes	29 "
Raises	69 "
Diamond drilling on third level	163 "

Ninety-five men were employed up to August 22nd, 1916.

The officers of the company are: President, W. R. P. Parker; vice-president, J. P. Watson; secretary, W. W. Perry; all of Toronto. The head office is at 1511 Traders Bank Building, Toronto. John W. Shaw, New Liskeard, is manager, and William Hooper, mine foreman.

Casey Mountain.—The Casey Mountain Mining Company, Limited, continued work in 1916 on the company's claim on lot 6, in the second concession, township of Casey. The operations were conducted by a syndicate of western men closely identified with the original company. During 1916, No. 2 shaft was sunk 150 feet, and on the date of inspection June 29th, 1917, had reached a depth of 315 feet, with 90 feet of drifting to the west on the 50-foot level, 10 feet on the 100-foot level, 35 feet on the 135-foot level, and on the bottom level at 315 feet two drifts were in progress. One heading to the southwest was in 75 feet, and the second drift running directly west of the shaft was in 25 feet. No. 1 shaft was abandoned during the year.

The officers of the operating syndicate are:—President, J. D. Martin, Regina; vice-president, H. M. Richardson, Ft. Qu'Appelle; secretary-treasurer, A. J. Cameron, Regina; directors, Geo. Speers, Regina; A. Cunningham, Moose Jaw; and manager, R. G. Williamson, Judge P.O., Ont.

The Toronto office is 115 Stair Building, Toronto, and Wm. A. Staples is secretary-treasurer of the Casey Mountain Mining Company, with R. G. Williamson president, and James Thompson, M.P.P., Havelock, vice-president.

Casey-Seneca Silver Mines, Limited.—The Casey-Seneca Silver Mines, Limited, continued work on the property in lot 6, concession VI, Casey township, until August, 1916, when all the surface equipment was destroyed by fire. The underground work was confined to prospecting on the 315-foot level. J. N. MacGuire was in charge of the work.

The officers of the company are: S. Harvey Worth, president; W. E. Segsworth, managing director; R. F. Segsworth, secretary-treasurer; A. C. Bailey, mine manager. The head office is at 103 Bay St., Toronto.

Cochrane.—The Crown Reserve Mining Company, Limited, began work at the Cochrane mine on June 15th, 1916. At the close of the year the shaft had been sunk from the 200-foot level to 570 feet, with stations at 100, 200, 300 and 550 feet. On the bottom level drifts were run north 100 feet and south 60 feet.

H. J. Stewart is manager, and Charles Froats superintendent, employing 11 men.

Coniagas.—The Coniagas Mines, Limited, has an authorized capitalization of 800,000 shares of a par value of $5.

The Board of directors are: R. W. Leonard, president and general manager; Alex. Longwell, vice-president; R. P. Rogers, F. J. Bishop, W. D. Woodruff, J. J. Mackan, secretary-treasurer; F. D. Reid, superintendent.

During the year a little over one million and three-quarters ounces of silver were mined and shipped, bringing the total production of this mine to 24,000,000 ounces. Two dividends of $200,000 each were paid, making the dividend record $8,140,000.

The yearly production of silver from the beginning has been as follows:—

Year Nov. 1 to Oct. 31	Tons	Mine Ore Ozs.	Tons	Concentrates Ozs.	Tons	Total Ozs.
1905-06	289.0	657,513.00	....	....	289.0	657,513.00
1906-07	2,655.0	1,341,372.00	....	....	2,655.0	1,341,372.00
1907-08	Mine ore	and concentrates			627.5	1,457,240.00
1908-09	350.0	807,313.00	426.0	599,975.00	776.0	1,407,288.00
1909-10	330.1	979,630.00	645.5	949,901.00	975.6	1,929,531.00
1910-11	619.1	2,142,961.71	1,418.4	1,646,312.20	2,037.5	3,789,273.91
1911-12	650.0	1,944,212.80	1,287.5	1,564,164.47	1,937.5	3,508,377.27
1912-13	735.8	2,249,394.32	1,034.3	1,323,004.56	1,770.1	3,572,398.88
1913-14	492.9	1,451,522.27	748.2	1,045,872.41	1,241.1	2,497,394.68
1914-15	274.0	940,432.59	629.7	1,061,620.91	903.7	2,002,053.50
1915-16	193.2	522,908.28	647.9	1,250,378.56	841.1	1,773,286.84
Totals	6,589.1	13,037,259.97	6,837.5	9,441,229.11	14,054.1	23,935,729.08

Statistics of mine development are:—

—	Total to Oct. 31, 1916	Total to Oct. 31, 1915	Work During 1915-16
Shaft Sinking, feet	875	875	....
Drifting, feet	17,611	16,608	1,003
Cross-cutting, feet	9,527	8,715	812
Winzing, feet	632	536	96
Raising, feet	1,067	1,004	63
Totals	29,712	27,738	1,974

During the year 56,972 tons of ore were milled.

Exploration work on the Agaunico property was stopped during the year. Options were taken on two gold properties in the Porcupine district.

The Coniagas Mines, Limited, owns 6,054 shares of the Wabi Iron Works, Limited, at New Liskeard, which has a capitalization of 40,000 shares of a par value of $1.

The company also own 2,494 shares of the authorized issue of 2,500 shares of the Coniagas Reduction Company. These shares have a par value of $100.

The Redington Rock Drill Company has an authorized capital of 1,000 shares of $100 par value; 220 shares have been issued of which the Coniagas Mines, Limited, own 117. As the entire operations of this company are confined to supplying the Coniagas Mines, Limited, it has been decided to wind up the company, and the mine will operate the plant and equipment.

Crown Reserve.—The Crown Reserve Mining Company, Limited, has an authorized capital of 2,000,000 shares of a par value of $1. The officers and directors are the same as for the Porcupine-Crown Mines, Limited. S. W. Cohen is general manager.

During the year 1916, 274,170 ounces of silver were produced, bringing the total production of the mine to 19,361,006 ounces.

Development work during the year amounted to 500 feet of sinking and raising, 2,000 feet of drifting and 700 feet of cross-cutting. The total development to date amounts to 32,786 feet.

The Crown Reserve Mining Company has a one-half interest in the Drummond Fraction; 10,150 ounces were produced from this property during the year.

About 1,000 feet of development was done on the Silver Leaf lease, principally on the 200-foot level.

The option on the Globe property in California was given up. An option was taken on some properties in Boston Creek, but was dropped after some months' work. A joint option was taken with the Dominion Reduction Company, Limited, on the Cochrane mine in Cobalt, adjoining the Timiskaming on the south, and the development of this property is now being actively carried on.

The Crown Reserve Company also owns about 90 per cent. of the stock of the Reward mine in California, and 60 per cent. of the capital stock of the Porcupine-Crown Mines, Limited.

Dickson Creek.—The Dickson Creek Mining Company, Limited, began work in June, 1915, on its claims on lots 9 and 10, concession V, township of Bucke, two and one-half miles north of Haileybury.

A shaft was started in October, 1916, and on the date of inspection, February 22nd, 1917, had reached a depth of 130 feet, on an inclination of 77° from the horizon. The plant consists of one upright 25 h.p. boiler, one Ingersoll-Rand compressor 500 feet capacity, and one 6 by 8 Jenckes hoist.

The shaft is in conglomerate from the surface and will be continued to the diabase contact.

The officers of the company are: President, Henry Higgins, London, England; director, Walter Eveling, London, England. H. Hollands-Hurst is manager, employing six men.

Dominion Reduction.—The Dominion Reduction Company operated its 40-stamp customs mill near Cobalt throughout the year. The ore treated came chiefly from the Crown Reserve and Kerr Lake mines, with small tonnages from the Chambers-Ferland and Cobalt Comet.

During the year 68,611 tons of ore were milled, having an average silver content per ton of 24.63 ozs. or a total silver content of 1,689,935 ozs. The milling capacity was increased by the installation of two 3-cell and two 2-cell Callow pneumatic flotation units. One Holt-Dern furnace for roasting flotation concentrates was also installed, with the necessary tanks for subsequent leaching and cyaniding of same.

It is the intention of the management to extend the plant to accept all kinds of concentrates for treatment.

The officers of the company are: President, D. M. Steindler, New York; vice-president, Sir Mortimer B. Davis, Montreal; general manager and secretary, Eugene L. Steindler, Cobalt; assistant manager, P. L. Blodgett, Cobalt.

Dominion.—Operations were resumed at the Dominion mine, formerly known as the Nova Scotia, in October, 1916. This mine has been closed since 1912, and the present owners, the Dominion Reduction Company, de-watered the workings at the main shaft, and did a small amount of stoping on the Bilsky vein (No. 1) also 40 feet of drifting. No. 2 shaft, which is 50 feet deep, was de-watered in June, 1917, and work resumed. These workings are not connected with the main shaft. No. 3 shaft near the office is 75 feet deep, and the main shaft 250 feet.

The officers are the same as given for the Dominion Reduction Company. Twelve men are employed.

Genesee.—The Genesee Mining Company, Limited, was organized in August, 1915, and a six-year lease taken from the United States Cobalt Mining Company, of the southwest quarter of south half of lot 9, concession I, township of Bucke.

On the date of inspection, February 17th, 1917, the shaft had reached a depth of 363 feet, and a station cut at the 350-foot level. The north drift at the 50-foot level had been abandoned, and a drift commenced to the west from the 350-foot station. This was later abandoned, and sinking resumed. Eight men were employed.

The directors of the company are: President, Ralph H. Gorsline, Rochester, N.Y.; secretary-treasurer, Alex. Russell, Rochester, N.Y.; A. A. Amos, Toronto, Ontario; manager, Leonard F. Steenman, Cobalt, Ontario.

Glen Lake.—The Glen Lake Mines, Limited, operated the Foster mine under lease from the Foster-Cobalt Mining Company, Limited. A cross-cut 1,600 feet in length was driven northeast from the shaft under Glen lake, and near the face of the cross-cut a winze was sunk to a depth of 60 feet. At this level drifts were run to the east 100 feet and to the west 50 feet. Work was discontinued in July, 1916.

The officers of the company are: President, C. B. Flynn, New York; secretary-treasurer, M. P. Van der Voort, 13 Wellington Street East, Toronto; manager and assistant treasurer, Thos. J. Flynn, Haileybury.

Hargrave.—The Hargrave Silver Mines, Limited, began operations at its mine in Coleman township adjoining the Drummond mine, November 15th, 1916.

No underground work was attempted until January 15th, 1917, and the period from November 15th to the close of the year was occupied in de-watering the mine and shipping mill rock from the dump. Four hundred tons of this material was hauled to the Dominion Reduction Customs mill.

The officers of the company are: President, George H. Sedgwick, Toronto; secretary-treasurer, James Aitchison, Toronto; manager, J. T. Shaw, Cobalt. Twenty-seven men are employed.

Hudson Bay. The Hudson Bay Mines, Limited, closed No. 2 mine in March, 1916, and in June, 1916, re-opened No. 1 workings adjoining the Trethewey.

The total development work done at No. 1 mine to the close of the year was as follows: Drifting, 275.5 feet; cross-cutting 150 feet; raising, 199.2 feet. Ten thousand and ninety-nine tons of ore were broken in the stopes. In October, 1916, two new veins were discovered on the surface to the north and west of the shaft, and subsequent development proved them to be of considerable length and value.

The mill was repaired and altered, and operations were resumed in September. To the close of the year, a total of 5,021.6 tons of ore was milled.

On January 1st, 1917, Douglas Mutch was appointed manager, succeeding G. G. Thomas, who had charge of operations during 1916. Underground work is in charge of Robt. McGrath, and 45 men are employed in the mine and mill.

The directors are: President, George Taylor; vice-president, A. A. McKelvie; S. S. Ritchie, T. McCamus, D. M. Ferguson, J. J. Grills, all of New Liskeard; C. L. Sherrill, Buffalo, N.Y.; secretary-treasurer, F. L. Hutchison, New Liskeard.

Kerr Lake.—The Kerr Lake Mining Company of New York, owns all the stock of the Kerr Lake Mining Company, Limited, of Ontario, 150,000 shares of Wettlaufer Lorrain Silver Mines, Limited, 200,000 shares of Kerr Lake Majestic mines, and 837,498 shares of Caribou Cobalt Mines Company's stock.

Development at the Kerr Lake mine, Cobalt, for the fiscal year ending August 31st, 1916, amounted to 4,056.8 feet as follows: drifting 1,975.0 feet; cross-cutting 1,737.3 feet; raising, 189.0 feet; and sinking 155.5 feet. Total stoping 11,008.0 feet, and total side-cutting, 1,189.5 feet. During the year 58,850 tons were hoisted at a mining cost of $3.68 per ton. Of this tonnage 45,743 tons were ore, and 13,107 tons waste. The production amounted to 2,433,793 ounces of silver at a total cost of 25.25 cents per ounce. This cost is made up as follows: mining and developing costs 8.89 cents; shipment and treatment charges 15.80 cents; administration and general cost 0.56 cents. The ore reserves on September 1st, 1916, were estimated to contain 3,827,000 ounces of silver.

Operations were resumed in a small way on the Drummond Fraction property in July.

A De Laval 3-stage, 350-gallon centrifugal pump, electrically driven, was installed at the main shaft on the 225-foot level to handle the total flow of water in the mine.

The officers are: President, Adolph Lewisohn; vice-president, Sam A. Lewisohn; secretary and treasurer, E. H. Westlake, all of 61 Broadway, New York; mine manager, H. S. Kee, Cobalt.

La Rose.—The La Rose Consolidated Mines Company has an authorized capital of 1,500,000 shares of a par value of $5 each.

The officers of the company are: D. Lorne McGibbon, president; Shirley Ogilvie, vice-president; Edwin Hanson, vice-president; Stephen J. Le Huray, secretary-treasurer; G. C. Bateman, general manager. The directors are: D. Lorne McGibbon, Victor E. Mitchell, K.C., Shirley Ogilvie, W. A. Black, Edwin Hanson, W. M. Dobell, E. W. Nesbitt, and S. J. Le Huray; head office, 260 St. James St., Montreal.

During the year 1916 the company's report shows the production of silver to have amounted to 740,065 ounces, the net value of which was $449,731. The cost of production was 16.39 cents per ounce, and the net selling price was 64.89 cents per ounce. The net profit on production was $461,774.04. Dividends paid during the year amounted to $299,725.40, bringing the dividend record of this property up to $7,235,109.56.

The development work during the year was as follows:—

——	Trenches	Drifts	Cross-cuts	Raises	Diamond Drilling	Stopes
	ft.	ft.	ft.	ft.	ft.	cu. yds.
La Rose.......	945	1,294	1,168.5	255	256.4	3,447
Lawson.......	....	264.5	316.	208	....	85
	945	1,558.5	1,484.5	463	256.4	3,532

The company did not operate the Princess, Fisher-Eplett and University mines during the year.

The tonnage milled was 54,229, the greater portion of which came from the La Rose dumps. There is a considerable tonnage on the dumps at the Princess and Lawson mines, which will be treated during 1917 if the price of silver remains at its present high level.

Working options were taken on a copper property in New Brunswick, a gold property at Porcupine, and a gold property at Kirkland lake. The first two were allowed to lapse, as development work did not give encouraging results.

Mercer.—The Mercer Silver Mines, Limited, continued operations on the Gould lease on Cart lake until February, 1917, when it was decided to cease operations, development work not having disclosed any new ore bodies.

The officers of the company are: S. H. Worth, president; R. F. Segsworth, secretary-treasurer; W. E. Segsworth, managing director; A. C. Bailey, mine manager. The head office is at 103 Bay St., Toronto.

Mining Corporation of Canada.—The Mining Corporation of Canada, Limited, owns 183½ acres in the Cobalt camp comprising the Cobalt Townsite, Cobalt Lake, City of Cobalt, Townsite Extension and Little Nipissing mines. The Cobalt Reduction Company, Limited, is also controlled by the corporation. The company is capitalized at $2,075,000 in shares of $1.00 each, all issued.

The directors and officers of the company are: Sir Henry M. Pellatt, president; J. P. Watson, first vice-president; W. R. P. Parker, second vice-president;

G. M. Clark, Lieut. J. G. Watson, D'Arcy Weatherbe, Capt. R. E. G. Van Cutsem; D'Arcy Weatherbe, consulting engineer; C. E. Watson, resident manager; M. F. Fairlie, superintendent of reduction works. The head office is at 1512-1520 Traders Bank Building, Toronto.

The following information is taken from the annual report of the company:

The production for the year 1916 was 4,457,440.80 ounces of silver, as compared with 4,563,957 ounces for the year 1915; and the net profits for the year 1916 amounted to $1,835,583.88, as compared with $1,193,395.44 for the preceding year.

During the year the amount of exploration and development work amounted to 14,789 feet.

The total tonnage treated was 114,392.13 tons, as against 131,852.24 tons for 1915, the total ounces recovered being 4,457,440.80, of which 1,464,161.74 ounces were from high-grade ore. The percentage of recovery was 92.14 per cent. in 1916, as against 90.72 per cent. in 1915.

Ore and Waste Rock.—The quantity of ore broken amounted to 68,645 tons, and 101,271 tons were hoisted from the mine.

Waste rock, amounting to 53,789 tons, was broken in the mine, of which 11,554 tons were hoisted and 12,245 tons were deposited in old stopes underground.

Of the total ore tonnage hoisted from the mine, 556.3 tons of high-grade were sent to smelters, 206.7 tons of high-grade were treated in the new high-grade plant of the Cobalt Reduction Company, while 99,480 tons were concentrated and 1,028 tons were placed on the ore dump.

The average silver production from total ore treated, including all high-grade and other classes of shipping ore and milling ore, was 38.966 ounces per ton, against 34.34 ounces per ton in 1915. The total production from these mines since their inception amounted to 23,129,040 fine ounces at December 31st, 1916.

Cobalt Lake Mill.—On account of improvements in the Cobalt Reduction Company's mill, the Lake mill was shut down on June 11th, 1916. There were no abnormal delays up to the date of the final shut-down.

Cobalt Reduction Company's Concentrating Mill.—This mill ran continuously (excepting holidays) during the year.

Townsite.—Very little exploration work was done on this property in 1916, but a considerable amount of ore, in excess of that contained in the previous year's reserves, was exposed by development work and in cleaning out old stopes previously considered to have been exhausted.

The ore reserve estimate of the resident engineer shows that, although a production of nearly one and three-quarter million ounces has been made during the year from this property, there still remain, available for extraction, 763,700 ounces.

Cobalt Lake.—Extraction was completed from those ore shoots, discovered in 1915 on the Fault Vein, early in the year, but exploration in the upper levels of the old workings near the lake bottom encountered several small patches of very rich ore which have substantially increased the silver production from the Lake property over the amount of the ore reserves developed at the end of 1915.

With the exception of development work still in progress on one of these patches, at the conclusion of 1916, the old southern workings of the Lake mine may for the present be considered as virtually abandoned.

The elaborate exploration programme, instituted in 1915, to prospect the central and northern portion of the Lake property, was very actively prosecuted during 1916.

The portion of this work completed during the past year consisted in driving a long, straight cross-cut (No. 24) up the centre of the Lake property on the 450-foot level. From this central cross-cut, branch cross-cuts, at intervals of about 200 feet, were turned off to right and left, those to the south-east being extended towards the lake fault, while those on the opposite side, in most cases, intersected the Keewatin formation.

Cross-cut No. 24 was extended to a point slightly beyond the prolongation of the strike of vein No. 24 (on the City property) and at a short distance south of this face branch cross-cuts were driven, one south-east to the fault vein, and the other (No. 41) northerly to connect with a winze (No. 4) from the No. 24 vein system workings, which was sunk on the Extension property. From the end of the first of these two cross-cuts long drifts were driven northerly and southerly on the fault vein, but, with the exception of a small patch of ore in cross-cut No. 39, no new discoveries were made in any of these workings on the Lake.

Simultaneously with this work on the Lake, extensions of the workings on the 24 Vein system on the City reached the Extension and Lake properties, and the somewhat unexpected conditions developed by this work, which is described in detail below, now indicate the probability that most of this northerly exploration work on the Lake is on a horizon too high for ore deposition.

The rock on the east side of the great "West" fault revealed by the work from the City property, above mentioned, has evidently suffered a downthrow of over 100 feet, and it is in this deep ground on the Lake that further hopes are centred. Winzes to prospect this area will now be sunk with the greatest speed.

City and Extension.—The work on the City property has chiefly been confined to the north-eastern portion of the property, where drifts on branch veins, off veins Nos. 24 and 29, have developed a new network of veins which, though in no individual case averaging as well in grade as the ore in Nos. 24, 27, or 29, have provided, and are still providing, large quantities of good milling ore, and in some cases rich, high-grade ore.

Vein No. 29 was followed southerly for several hundred feet from its junction with No. 24 vein, and has proved to be one of the best producers on the combined properties.

The drift on the 300-foot level, on vein No. 24, which was continued easterly through the top of the ore shoot on that vein, reached the Lake property towards the middle of the year, and near the western boundary of the Extension property passed through a great fault with a northerly and southerly strike and a flat dip towards the east. Subsidiary and parallel faulting also occurs with the main fault, the whole line of dislocation roughly paralleling the direction of the Extension property in this region.

Subsequent development work has identified this fault with the great *West* fissure, which has been explored and intersects several of the properties to the north of the City and Extension.

By analogy with neighbouring development work, and as indicated by our own work, the area on the east side of this fault appears, as stated above, to have been thrown down vertically over one hundred feet.

On the Extension property, in the drift in continuation of Vein No. 24, a winze has been sunk to the Keewatin formation, and a connection made with the Lake workings on the 450-foot level, through cross-cut No. 11. Near the junction of this cross-cut with winze No. 4 a strong vein carrying smaltite was intersected in the Keewatin, which, being followed upwards through the contact into the conglomerate formation, has increased in size and produced richer ore than was ever before exposed in any portion of the workings. The vein in some places exceeded six inches in thickness, and some of the ore would assay over 15,000 ounces per ton.

At a depth of 86 feet in winze No. 4 a station was cut and a cross-cut to the north intersected an extension of this vein west of where first encountered and at a higher point on its pitch. Further development has practically proved this ore to be an extension of the main ore shoot on vein 24, which is now shown to extend continuously from the northern boundary of the City property (where it dies out) to the great West fault—a total distance of over 700 feet. The ore shoot on its eastern extension is, so far as shown by present development work, not so high as at its western end, as it is bounded here on its lower side by the Keewatin formation and, about twenty feet higher up, by a subsidiary fault roughly paralleling the contact.

Winze No. 4 has also been connected on the 386-foot level by a long cross-cut (No. 8), which runs southerly, down the centre of the Extension property, through the old City workings, and connecting with the main (No. 7) hoisting shaft. All the ore from these northern workings will be carried through this haulage way, which should effect a material economy in cost and increase in capacity. In this cross-cut, No. 8, two veins, Nos. 39 and 40, have been cut and show silver contents. The cross-cut north from winze No. 4 on the 386-foot level will be further extended in that direction to prospect the Extension property on that horizon and on the west side of the West fault.

Little Nipissing.—Exploration continued on this property, and during the latter part of the year was confined to work on the Lake fault, which extends southerly through the claim. In a drift on the fault, patches of ore carrying a large percentage of cobalt and assaying in places over 1,000 ounces per ton, were encountered. As this ore chiefly occurs near the bottom of the drift, a winze will be sunk on the fault to the Keewatin contact, and drifts will be run southerly in the hope of intersecting an ore shoot.

Details of Mining Work and Labour.—The following summarized tables give details of work accomplished in the various operations at the mine:

FOOTAGES IN 1916

	Lineal feet of working place advanced					Cubic Feet Stoping
—	Driven	Crosscut	Sunk	Raised	Total	
Ore Extraction	....	....	....	39	39	753,727
Development	2,148	....	18	257	2,423	....
Exploration	2,213	9,301	274	578	12,366	....
Total	4,361	9,301	292	874	14,828	753,727

Diamond drilling amounted to 985 feet, of which 576 feet were from the surface and 409 feet from underground. The total footage of drifts, cross-cuts, raises, winzes and shafts in the workings of the Mining Corporation properties amounted to an aggregate of over 19 miles at the end of 1916.

SUMMARY OF ORE RESERVES

—	Tons Ore 1916	Ounces Silver 1916
High-grade ore	743.7	1,729,800
Milling ore	64,008.0	1,505,200
Total	64,751.7	3,235,000

The total amount is made up of 21,092 tons, carrying 1,688,125 ounces, in place, and 43,503 tons, carrying 1,546,875 ounces, of broken ore in stopes and on the dumps.

McKinley-Darragh.—The McKinley-Darragh-Savage Mines of Cobalt, Limited, has an authorized capital of 2,500,000 shares of a par value of $1. The directors and officers of the company are: J. R. L. Starr, president; Thos. W. Finucane, vice-president; J. H. Spence, secretary; Harper Sibley, treasurer; Joseph S. Hunn, asst. treasurer; H. W. Sibley, G. L. Thompson, T. R. Finucane, manager. The office of the secretary is at 58 Canada Life Building, Toronto.

During the year 1916, 925,779 ounces of silver were recovered, bringing the total to 16,111,346 ounces since the mine was opened in 1906. The average price received for silver during the year was 67.361 cents and the total costs 40.73 cents.

The estimated ore reserves on Jan. 1st, 1917, remain about the same as at the beginning of 1916, being 1,711,302 ounces.

The dividends authorized during the year were four, amounting to $269,723.04.

The tonnage milled during the year amounted to 62,676, silver recovered to 764,167 ounces. A flotation mill was installed for the treatment of mill slimes.

The distribution of the underground work during the year was as follows:—

McKinley

Levels	Shafts feet	Drifts feet	Cross-cuts feet	Stopes tons	Raises feet	Winzes feet	Shaft Stations cubic yards
Surface				1,716			
75 feet		95	113	4,251	141.5		
110 "		373.5	34.5	4,602			
150 "		158	127	5,093	25		
200 "		629.5	165.5	12,469	4.5		
250 "		296	69.5	10,250	283	246.5	41
300 "	3.5	123.5	392.5		20		112
400 "		283	370.5		142		85
Total McKinley.	3.5	1,958.5	1,272.5	38,381	616	246.5	238

Savage

Levels	Shafts feet	Drifts feet	Cross-cuts feet	Stopes tons	Raises feet	Winzes feet	Shaft Stations cubic yards
70 feet		26		263	15	12.5	
85 "				88	11		
88 "				30			
120 "		19.5	13				
140 "		202.5	337	687	18.5	13	
162 "		99.5	36.5	425			
165 "		40	15.5	655	11.5		
190 "		73.5	134	111	66.5	7.5	
210 "				17			
240 "				56			
290 "		24.5		12			
Total, Savage		485.5	536	2,354	122.5	33	
Combined Total.	3.5	2,444	1,808.5	40,735	728.5	279.5	238

National.—The National Mines, Limited, began work April 1st, 1916, on the King Edward claim west of Cross lake. The property was last worked by the York Ontario Silver Mines, Limited, which held a lease from the King Edward Silver Mines, Limited. This lease has been acquired by the National Mines, Limited.

The winze has been sunk to a depth of 810 feet below the tunnel level, or 1,000 feet below surface. A cross-cut was run at this level, a distance of 185 feet from the winze, north 68° east.

On the date of last inspection, May 28th, 1917, a drift 870 feet in length had been driven north 20° west from the winze, in the general direction of the old Silver Cliff workings.

During the year, in addition to the above work underground, the mill was repaired and equipped with one triple cell Callow rougher and two single cell cleaners, and sand tailings from Cross lake treated by flotation.

The officers of the company are: President, H. E. Jackman; secretary-treasurer, Ernest C. Whitbeck, both of 17 Ellwood Building, Rochester, N.Y.; director, S. Jardine, Toronto; and C. A. Filteau, manager, box 749, Cobalt.

Underground work was in charge of J. N. McGuire, Cobalt, on contract. Twenty-five men were employed in the mine and mill.

Nipissing. The Nipissing Mining Company has an authorized and issued capital of 2,500 shares of a par value of $100. The officers of the company are: David Fasken, president; E. P. Earle, vice-president; Arch. T. Struthers, secretary; P. C. Pfeiffer, treasurer. The directors are: W. H. Brouse, David Fasken, E. P. Earle, Richard T. Greene, R. B. Watson. The operating officials are: R. B. Watson, general manager; Chas. Butters, consulting metallurgical engineer; Hugh Park, manager; Jas. Johnson, mill manager; Jas. J. Denny, manager research department. The head office of the company is at the Excelsior Life Building, Toronto.

The stock of the Nipissing Mining Company is held by the Nipissing Mines Company, with an authorized and issued capital of 1,200,000 shares of a par value of $5. The officers of the company are: E. P. Earle, president; Richard T. Greene, secretary; P. C. Pfeiffer, treasurer. The directors are: W. H. Brouse, Richard T. Greene, E. P. Earle, August Heckscher, David Fasken, and R. B. Watson. The head office of the company is at 165 Broadway, New York.

The following information is taken from the annual report of the company for the year 1916:

The average price received for silver during the year was 68.79 cents per oz.

The total dividends paid to Jan. 20th, 1917, amounted to $15,540,000, or 259 per cent. of the capitalization.

The production of fine silver was 4,011,668.49 ounces, the gross value being $3,027,668.63. Production costs were $976,185.70. The net result was $2,051,482.93.

The surplus was increased $193,865.91, and now stands at $1,980,126.87.

Stockholders received during the year $1,800,000, as against $1,200,000 during the previous year.

The known ore reserves contain 9,153,139 ounces of silver, compared with 8,921,718 ounces the previous year. The value of the silver in the ore reserves is largely in excess of the value a year ago, by reason of the advance of approximately 27 cents per ounce in the price of silver.

Underground work done in 1916 is summarized as follows:—

Shaft No.	Drifting feet	Cross-cutting feet	Raising feet	Sinking feet	Total feet	Stoping Cubic Yards
14..........	373.5	801.0	59.5	9.0	1,243.0	206.0
64..........	52.5	46.0	15.0	....	113.5	....
73..........	1,308.5	662.0	529.5	91.5	2,591.0	9,627.6
80..........	20.5	1,499.5	17.0	200.5	1,737.5	1,474.7
81..........	1,327.0	457.5	10.5	470.0	2,265.0	....
96..........	570.0	350.5	87.5	170.0	1,178.5	....
123..........	....	....	....	....	....	197.4
Total....	3,652.0	3,816.5	719.0	941.0	9,128.5	11,605.7

Diamond Drilling (all underground at shafts 73 and 80)....429.5 feet.

Reserves of developed and partly developed ore at 31st December, 1916 were:

Shaft No.	High Grade Ore		Mill Ore		
	Tons	Ounces	Tons	Assay	Ounces
64	203	200,403	3,992	20	79,840
73	1,522	2,552,040	61,421	25	1,535,525
490	1,539	1,309,689	20,501	30	615,030
80	115	255,200	3,482	25	87,050
100	21	31,200	821	25	20,525
63	191	467,900	8,370	24.3	203,395
96	79	214,800	2,559	25	63,975
14	......	......	179	25	4,475
	3,673	5,031,232	101,325	25.8	2,609,815
Dumps	......	......	62,396	24.2	1,512,092
			163,721	25.2	4,121,907

	Tons	Assay	Ounces
High Grade Ore	3,673	1,370.	5,031,232
Mill Ore	163,721	25.2	4,121,907
Total	167,394	55.	9,153,139

Increased costs of labour, supplies, taxes and insurance brought the mining costs up to $12.53 per ton of ore or 24.13 cents per oz. of silver, compared with $10.02 per ton and 19.06 cents per oz. in the previous year.

Owing to the high price of silver throughout the year, the net profits were $610,000 more than in 1915 on about the same production.

O'Brien.—The development work done at the O'Brien during 1916 was as follows:—

Drifting and cross-cutting 5,500 feet; raising, 240 feet; sinking, 117 feet; total, 5,857 feet. A new level was established at 610 feet, and stoping done mostly in the vicinity of No. 7 and No. 16 shafts.

Milling operations were carried on with no change of plant. Sodium sulphide precipitation replaced aluminium dust precipitation in the cyanide plant. Aluminium dust has risen to a prohibitive price, and the present process is much cheaper.

Work was continued throughout the year on claim A 1 on the Gillies limit, but nothing of interest was encountered.

M. J. O'Brien is owner of the mine, and J. G. Dickenson, manager.

Penn-Canadian.—The Penn-Canadian Mines, Limited, operated continuously during 1916.

For the year ending April 30th, 1917, the development work done was as follows:—

—	Drifting	Cross-cutting	Raising	Winze-sinking	Totals
1st Level..........	192.2	107.8	....	....	300.0
3rd Level..........	4.0	....	30.1	....	34.1
4th Level..........	46.9	292.6	43.1	....	382.6
5th Level..........	388.3	108.7	....	7.0	504.0
6th Level..........	804.8	320.3	144.0	18.2	1,287.3
Total......	1,436.2	829.4	217.2	25.2	2,508.0

No change has been made in the mill since the 1915 report.

The officers of the company are: President, William J. Haines, Philadelphia; directors: Spencer D. Wright, Philadelphia; Robt. B. Haines, Jr., Philadelphia; Jansen D. Haines, Des Moines, Ia.; Elliott C. P. Laidlaw, New York.

Balmer Neilly, Cobalt, is manager of the company, employing 90 men.

People's.—An agreement was made between the People's Silver Mines, Limited, and the Ophir Cobalt Mines, Limited, whereby each company was to share equally the expense of sinking the People's mine shaft, formerly known as the John Black, from the 300-foot level to the Keewatin-diabase contact, also the cost of drifting to the Ophir boundary. From this point each company assumes its own costs underground, and divides the hoisting, surface and overhead expenses in proportion to the number of machines working. In this manner the properties of both companies will be developed.

During the year the shaft was sunk to the 400-foot level, and 415 feet of drifting and cross-cutting performed. The underground work has been done by contract, under the direction of W. J. Donaldson.

Balmer Neilly is consulting engineer for the two companies. Ten men were employed.

The officers of the People's company are as follows: President, G. B. Bithell, 773 St. Lawrence Boulevard, Montreal; vice-president, James Robertson, Millerton, N.B.; secretary-treasurer, T. Jones, 773 St. Lawrence Boulevard, Montreal.

Peterson Lake.—The Peterson Lake Silver Cobalt Mining Company, Limited, has an authorized capital of $3,000,000. The directors of the company are: Col. Sir Henry Pellatt, president; S. G. Forst, managing director; Max. B. Berg, Irving L. Ernst, Chas. M. Nickel, W. A. Lamport, secretary-treasurer. The head office is at 909 Excelsior Life Building, Toronto.

During the year $126,095.55 was paid in dividends. None of the company's property is now under lease. The Nova Scotia section was worked for part of the year. In April, 1917, work was commenced on the Susquehanna section at the extreme northeast end of the lake.

Development work for the year footed up as follows:—

—	Cross-cutting	Drifting	Sinking	Raising	Stoping
Mercer Lease..........................	825	281	....	....	....
Reliance...............................	98	207	43	....	....
Peterson Lake—Nova Scotia Section...	653	834	14	134	467

Prince-Davis.—In March, 1917, the Prince Davis Mining Company, Limited, began exploration of the Prince lot in southeast Coleman. Operations were carried on through the Lumsden shaft, and a station cut at the 250 foot level. From the station a drift was run 75 feet, then a cross-cut 295 feet to the Prince line through the Lumsden in a southeasterly direction. This was continued into the Prince ground, and the lot thoroughly prospected.

Underground work is in charge of W. J. Donaldson, and Balmer Neilly is consulting engineer for the company. Messrs. Gordon and Robert Cameron have the contract for drifting and cross-cutting, employing 8 men.

Right-of-Way.—The Right-of-Way Mines, Limited, continued development work during 1916. On March 15th No. 3 shaft was closed and work for the balance of the year confined to No. 2 shaft, near the north end of Cobalt lake. The following development work was done at No. 2 shaft:—

Sinking	62 feet.
Raising	75 "
Drifting	210 "
Cross-cutting	80 "

Work on the Cobalt Lake fault below the 365-foot level has not yet produced any ore, but the work will be continued during 1917.

The quantity of silver produced in 1916 was as follows:—

Ore shipments containing	148,959.61 ozs.
Ore on hand containing	7,367.57 "
Total	156,327.18 "

The head office of the company is at 16 Elgin Street, Ottawa.

The directors are: President, E. Seybold, vice-president, A. W. Fraser, K.C.; secretary-treasurer, E. A. Larmonth; director, C. Jackson Booth, all of Ottawa.

D. H. Angus, Cobalt, is superintendent.

Rochester.—Work at this mine in southeast Coleman was continued during 1916 by the Trethewey Silver-Cobalt Mining Company, Limited.

Work was carried on from the 300-foot level of the Lumsden shaft. Development consisted of:—

Drifting	836.8 feet.
Cross-cutting	419.5 "
Raising	114.1 "
Sinking	41.5 "

Low silver values were encountered in a number of places and a small amount of stoping done on number 305 vein. Work was abandoned in the spring of 1917. Fifteen men were employed during the year.

H. S. Robinson is superintendent, and Charles A. Froats, mine captain.

Seneca-Superior.—The Seneca-Superior Silver Mines, Limited, ceased operations in June, 1916, the known ore bodies being exhausted, and development work not having disclosed any new ore bodies. The mine has produced over five million ounces of silver in a little over four years.

The officers of the company are: S. H. Worth, president; F. W. Zoller, vice-

president; R. F. Segsworth, treasurer; W. E. Segsworth, managing director; R. H. Lyman, manager. The head office is at 103 Bay St., Toronto.

Shamrock.—The Shamrock Consolidated Mines, Limited, continued to develop its property during 1916. The claim owned by this company adjoins the Beaver mine on the north.

The mine was shut down on March 22nd, 1916, and only a small amount of work was done till June 19th, 1916, when it was again opened and worked continuously till the close of the year. The shaft is 417 feet deep with levels at 100, 200, 300 and 400 feet. All work during the year was confined to drifting on third and fourth levels. No ore was shipped.

J. B. Cleveland, Cobalt, is manager of the company, and H. S. Anderson, 93 Queen St., East, Toronto, secretary.

Underground work is in charge of Walter Purdy, employing ten men.

Temiskaming.—The Temiskaming Mining Company, Limited, has an authorized capital of 2,500,000 shares of a par value of $1. The officers of the company are: Frank L. Culver, president and general manager; W. T. Mason, vice-president; H. E. Tremain, treasurer; R. Graham, secretary. The directors are: J. H. Black, F. L. Culver, F. L. Lovelace, W. T. Mason, W. E. Stevenson, H. E. Tremain, F. C. Finkenstaedt. The head office is in the Lumsden Building, Toronto.

The company are interested directly or indirectly in the following properties:—

Daigle Claim: S. ½ of N.W. ¼ of N. ½, lot 1, con. 3, Coleman township, 20 acres.

Gans Property: W. ½ of S.W. ¼ of N. ½, lot 1, con. 3, Coleman.

McDonald Claims: E. and W. halves of S.W. ¼ of S. ½, lot 2, con. 4, Coleman township, 40 acres. Gillies Siding.

Peterson Claim: N.W. ¼ of S. ½, lot 13, con. 2, Bucke township, 40 acres.

Osland Claim: S.W. ¼, N. ½, lot 8, con. 3, Bucke township, 40 acres.

McCool Township: N.W. ¼, N. ½, lot 2, con. 2, 40 acres.

Cook Township: N.E. ¼ of S. ½, lot 1, con. 1, 40 acres.

Barnet Township: N.W. ¼ of S. ½, lot 12, con. 1, 40 acres.

Morrison Claims: Part of W. ½ of S.E. ¼ of S. ½, and part of E. ½ of S.W. ¼ of S. ½, of lot 8, con. 4, Coleman; also part of W. ½ of N.W. ¼ of N. ½, lot 7, con. 4, Coleman township. These three claims are commonly known as the Red Jacket claims.

J. Macdonald Claim: E. ½ of N.W. ¼ of N. ½, lot 10, con. 3, Coleman township.

North Dome: Properties are known as Claims Nos. 13197, 13198, 13199, Porcupine Mining Division.

During the year 1916 the production from the Temiskaming mine, Cobalt, was 1,263,848 ounces of silver, of which 630,417 ounces were from high-grade ore, 333,431 ounces from mill ore. The cost of production was 26.4 cents per ounce.

The main shaft was sunk 608 feet, making a total depth of 1,169 feet. The development underground was as follows:—

Drifting	2,292.7 feet
Cross cutting	915.9 "
Sinking	608.0 "
Raising	1,384.3 "
Station cutting	42.0 "
Total	5,242.9 "
Stoping	11,508.2 cubic [illegible]

Three dividends of $75,000 each were paid during the year.

Trethewey.—The mine of the Trethewey Silver-Cobalt Mining Company, Limited, was reopened and milling resumed June 1st, 1916, following the improved market conditions of the early months of 1916. Operations were continuous for the balance of the year.

Development for this period was 1,031 feet, including 261 feet of cross-cutting and raising around No. 6 shaft. A total of 10,129 tons of ore was broken in the stopes, mostly derived from slashing the walls of old stopes.

The mill treated a total of 18,511 tons of ore, averaging 16.3 ozs. of silver per ton. The sand tailings were sampled and measured, and found to total 65,000 tons with an average content of 1.7 ozs. per ton. The method of treating these tailings has not yet been decided.

The Rochester mine owned by the company is described elsewhere in this report.

The company de-watered the Lucky Cross gold mine at Swastika, and did 200 feet of drifting and cross-cutting at the bottom level. Work was started February 26th and discontinued in May.

The new board is as follows: President, S. R. Wickett, Toronto; vice-president, J. B. Tudhope, Orillia; secretary-treasurer, L. J. Pashler, Toronto; and directors, Gordon Taylor, Toronto; J. P. Bickell, Toronto; W. J. Sheppard, Waubaushene, Ont.; T. E. Leather, Hamilton.

The head office is at 1,128 Traders Bank Building, Toronto. H. S. Robinson, Cobalt, is manager.

Northern Customs.—The Northern Customs Concentrators, Limited, at mileage 104, T. and N. O. railway, ran continuously in 1916. The ore treated came from La Rose, Right-of-Way, and Chambers-Ferland mines.

The company recently installed a Callow pneumatic flotation, double compartment, triple length cell, replacing the vanners.

The officers of the company are: President, A. J. Young, 702 Excelsior Life Building, Toronto; vice-president, C. J. Booth, Ottawa; general manager and secretary-treasurer, F. J. Bourne, Cobalt; directors, M. J. O'Brien, Renfrew, and Dr. C. W. Haentschell, Haileybury; A. S. Holmes, Cobalt, is superintendent, employing 50 men.

The Flotation Process at Cobalt

The following notes on flotation in the Cobalt camp were furnished by E. B. Thornhill, representative at Cobalt of the General Engineering Company; Robert E. Dye, mill superintendent of the Buffalo Mines, Limited, Arthur A. Cole and Frank Groch, Cobalt.

It may be definitely stated that flotation has passed through the experimental stage in the Cobalt camp, and is now firmly established as the most economical method of saving the silver values in the Cobalt ores formerly not recovered by gravity methods of concentration.

It cannot be said that flotation practice has replaced standard gravity concentration to the same extent as in the copper mining camps of the west, but it is particularly adaptable to the recovery of the more friable silver minerals and fine leaf silver, which escape recovery by ordinary gravity concentrating machinery.

The first experimental plant operating on a tonnage scale was built in October, 1915, by Buffalo Mines, Limited, to determine the feasibility of concentrating the silver values in the stacked sand tailings from previous concentrating methods. This experimental plant consisted of a two-compartment standard length Callow rougher cell, and one one-half size Callow cleaner cell.

The results obtained were so satisfactory that the Buffalo Mines, Limited, erected a Callow flotation plant of 600 tons daily capacity to treat its sand tailings. This plant was put in operation in September, 1916.

In June, 1916, the McKinley-Darragh-Savage Mines began operations with a 200-ton Callow installation to treat slimes. This plant has since been increased, and during the summer of 1917 an entirely new tailings mill was erected.

These two initial plants demonstrated on a commercial scale the adaptability of the flotation process to the mill products and low-grade ores of the Cobalt district. At present the following mills use the Callow Pneumatic System of flotation in the Cobalt district:

Buffalo Mines, Limited; McKinley-Darragh-Savage Mines; Nipissing Mines; Coniagas; Dominion Reduction Company; Northern Customs Concentrators, and the National Mines. Of these mentioned, the Coniagas and Dominion Reduction have each added 200 tons daily capacity to their initial installation, and in the new tailings mill of the McKinley the flotation unit will be greatly increased.

Grinding.—It has been found that the economic limit of grinding for flotation appears to be reached when not more than 1 or 2 per cent. is retained on a 100-mesh screen.

Oils Used.—Practically all the plants use an oil mixture consisting of pine oil, coal tar creosote and coal tar. A mixture of 15 per cent. pine oil, 75 per cent. coal tar creosote, and 10 per cent. coal tar is very efficient.

In this connection it might be noted that the greatly increased demands for pine oil, which had to be imported from the Southern States, led to the inevitable results, extremely high price and an adulterated product. Due to these conditions, attempts were made by Tom R. Jones, of Buffalo Mines, to produce a suitable oil from the stumps of the Northern Ontario pine. Some success was attained, and in conjunction with Arthur A Cole, president of the Canadian Mining Institute, the Dominion Government was interested in the matter, and a plan outlined whereby the Mines Branch at Ottawa working with the Forestry Branch would attack the problem, it being considered one of national importance.

Investigations were commenced in July, 1916, by C. S. Parsons, representing the Mines Branch, and R. E. Gilmore, the Forestry Branch, the Forest Products Laboratories at McGill University being utilized for the experiments.

This investigation followed two lines: (1) the production of pine oil in Canada commercially, (2) the finding of a substitute for pine oil in Canada.

Careful experimentation and investigation of plants already established in Canada and producing wood products, led to the conclusion that the establishment of such an interest in Canada would require a large capital outlay, and even under the most careful management an adequate financial return was not assured. Pine oil forms only a small percentage of the total products of distillation, and at present the markets for the other materials produced are very irregular. A company has been formed at Cobalt, and a small plant erected at Cassidy on the T. & N. O. railway south of Cobalt. The work this plant is doing may lead to very important results.

As to a substitute, it was found that several of the hardwood distillation products made good frothing agents, and that two of the best frothing agents were products from hardwood distillation which had hitherto been wasted. These were two of the hardwood creosote oils.

Recently several barrels of this material were shipped to Cobalt, and a test run under commercial conditions was made at the Buffalo mill. The full capacity of the mill was turned over to Messrs. Parsons and Gilmore, and 600 tons per day for a week was treated by flotation, using these oils exclusively. The results were entirely satisfactory and will be published soon jointly by the Mines Branch and Forestry Branch, Ottawa.

Recovery.—Recoveries by flotation are found to vary over a wide range at the different plants, depending on the product going to flotation, the grade of concentrate required, and the experience of the operators. This last factor will be negligible in time, as there will soon be many efficient operators in the district.

The following table gives the value of the heading, tailing and concentrate and the percentage recovery at the McKinley-Darragh-Savage Mines, from mine and mill slime, for the months of December, 1916, and January, 1917. The averages are for quarter-month periods.

Month	Period	Heading	Tailing	Concentrate	Per Cent. Extraction
December	1st	5.36	1.68	220.0	69.19
	2nd	6.56	1.01	206.0	85.02
	3rd	7.10	1.03	289.0	85.80
	4th	7.55	1.15	443.0	84.98
January	1st	6.65	1.17	568.0	82.58
	2nd	7.30	1.20	436.0	83.80
	3rd	5.70	1.00	364.0	82.68
	4th	4.70	0.90	335.0	82.95
Average		6.37	1.14	357.6	82.13

Disposal of Concentrates.—Due to the present excessive marketing charges, it is economical to produce the high-grade concentrate, even at the sacrifice of recovery. With the exception of Buffalo Mines and Dominion Reduction, the companies producing flotation concentrate depend on United States smelters for the disposal of their products, and the schedules are high. A representative schedule stipulates a $12 to $14 treatment charge per ton, and payment on New York quotation of 95 per cent. of the silver content. With silver at present price, 80 cents per ounce, the marketing cost per ton of a 300-ounce concentrate would be approximately as follows:

Silver loss, 5 per cent.—15 ounces at 80 cents	$12 00
Treatment	14 00
Freight	11 32
Bagging and miscellaneous	2 00
Representation at the smelter	50
Total marketing cost for 1 ton of concentrate	$39 82

This excessive charge, equivalent to 20 per cent. of the market value of the product, led to extensive research work by the metallurgists of the district to devise a satisfactory method for the local treatment of such concentrate.

In this connection reference may be made to the paper presented by Robert E. Dye, of Buffalo Mines, Limited, at the 1917 annual meeting of the Canadian Mining Institute. This carefully-written report describes in detail the work done over a long period at the Buffalo mill and the results obtained. These may be summed up as follows: A chloridizing roast, followed by leaching, either with cyanide or an acid-brine solution, has given the best results to date. By this method a 95 to 98 per cent. extraction of the silver values is being obtained.

Roasting Furnace.—The Holt-Dern furnace has been found to offer several advantages over the ordinary reverberatory type. This furnace is simple in construction, and cheap in operation. The standard roasting furnace consists of a rectangular roasting chamber 7 feet by 9 feet by 4½ feet deep, with a hoppered bin under the grates for the discharged product. The fuel for the roast is furnished by the sulphur in the charge, and the roast is maintained by an air blast of 2,000 cubic feet per minute and 12 to 16 ounces pressure per square inch. Products to be roasted, with the requisite amount of salt, additional sulphur (if necessary, in the form of pyritic ore), are all intermittently mixed, and then moistened to the proper degree. Assuming the furnace to be in running order, the cycle of operations is about as follows: With the roasting zone within about two feet below the top of the furnace chamber, the mixed charge, equivalent to about 20 inches of depth, is dropped into the furnace and levelled off. The blast is turned on, and the roasting zone again moves up through the charge at the rate of about one foot an hour. When the roasting zone has again reached the top of the charge, the blast is turned off and the grates shaken until the charge is again lowered about 20 inches. This completes the cycle. The roasted product is withdrawn from the hopper bin underneath the grates and transported to the leaching department.

The use of an acid-brine solution to dissolve out the economic metals, as practised at the Tintic Milling Company, Silver City, Utah, would seem to offer some economy over the use of an acid leach, followed by cyanidation, but this has not yet been demonstrated on a commercial scale on Cobalt concentrates.

The Buffalo Mines has at present (July, 1917) one standard Holt-Dern (7 by 9 feet) ready for operation, and the leaching plant is being erected.

The Dominion Reduction Company installed two Holt Dern furnaces, each 4½ feet by 4½ feet, inside measurements. These two furnaces will have about two-thirds the roasting capacity of the Buffalo installation, and the plant will be extended to treat custom concentrates.

There are now in the district, Callow Pneumatic installations of 2,350 tons daily capacity, and three Holt Dern furnaces mentioned above of 21 tons daily capacity of flotation concentrate.

In addition to the Callow Pneumatic installations described above, there are several Groch Centrifugal Flotation machines installed at various mills in the district. This machine is the invention of Frank Groch, of the Grodwards Company, Cobalt, and may briefly be described as follows: The machine consists of a V-shaped box divided into compartments, in each of which operates a specially designed impellor having the combined functions of atomizing the oil, agitating the pulp centrifugally, and sucking the air into the mass during the agitation. The impellor is a vertical hollow shaft, with a contrivance at its lower extremity resembling a duplex centrifugal pump, or a turbine divided horizontally by a disc. The full-sized machine in operation has six impellors, and on the fine slime from Cobalt silver ore has a capacity of 25 tons per day. With fine sand the capacity will be much larger.

In action the pulp enters the first compartment of the V-box at the bottom, is sucked up by the lower portion of the duplex centrifugal impellor, and discharged in such a manner as to cause a tendency for the impellor to be thrust upward, its weight thus being reduced on its bearing and lessening the power consumption.

The oil and air enter the pulp through the impellor, by passing down the hollow shaft and being discharged at the periphery of the impellor, thus being brought into contact with the sulphides of the pulp under conditions for successful flotation. The rest of the operation is very similar to that of any other flotation machine. The oiled sulphides rise to the surface, and flow over the lips of the V-box, while the pulp, thus impoverished, settles and slides down the inclined planes into the first compartment, to be sucked up into the impellor of compartment No. 2, and the operation completed.

The following mills have Groch machine installation: Coniagas, Trethewey, McKinley-Darragh, Northern Customs Concentrator, Beaver, Miller Independence, and the Metals Chemical Company, Welland.

Copper

Mendel.—A small amount of work was done on the Mendel claim, south shore of Portage bay, in September and October, 1916. The vein is said to be four feet wide, carrying good values in chalcopyrite. A shaft was sunk to a depth of 24 feet, and about 50 tons of ore put on the dump. This was cobbed to about 12 tons, said to run 15 per cent. copper.

The work was done by Messrs. Lyman and Marsden, of Cobalt.

Elk Lake Silver Properties

Mapes-Johnston. The Mapes-Johnston claim near Silver Lake in the township of Mickle, worked with a small force of men during the year. A winze was sunk from the 200- to the 400-foot level, and a drift run northeast on the vein a distance of 115 feet.

The mine closed down in February, 1917. Ten men were employed under superintendent D. G. Oliver.

Kenabeek. The Kenabeek Consolidated Silver Mines, Limited, began operations in February, 1916, on the south half of lot 2 in the sixth concession of Auld township. A wagon road was built from Kenabeek station on the Elk Lake branch of the T. & N. O. railway a distance of 6 miles to the property.

In July, 1916, the shaft had been sunk to the 126-foot level and 120 feet of drifting and cross-cutting done on the bottom level.

The plant consists of 2 Jenckes locomotive type boilers, 40 h.p. each, and one 4-drill Jenckes compressor.

The officers of the company are: President, Frank Thompson, secretary-treasurer, George Pyke, with head office at 232 St. James Street, Montreal; Capt. W. H. Jeffery is manager, employing 16 men.

Gowganda Silver Mines

Bishop.—The Bishop Silver Mines, Limited, worked continuously throughout the year on claim L.O. 313, situated on the east side of Calcite lake, township of Lawson. When inspected on February 28, 1917, the adit from the foot of the hill on the lake shore had been driven 525 feet, and 500 feet of cross-cutting done at several points in the tunnel. No. 1 winze, 300 feet from the portal is 18 feet deep, and No. 2 winze at the end of the main drift was 90 feet deep. It was the intention of the management to sink this winze to the 100-foot level, and do about 500 feet of cross-cutting and drifting on this level. All the work is in diabase.

The officers of the company are: President, Stuart Lindsley, Orange, N.J.; secretary-treasurer, C. S. McKune, 109 West 55th St., New York, N.Y.; directors, J. H. Bishop, Wyandotte, Mich.; Joseph Tyson, Morristown, Penn.; George Rosendale, New York, N.Y.; Robt. W. Goffe, New York.

Wm. J. Shields, Wigwam P.O., is manager, employing 10 men.

Crews-McFarlane.—The Crews-McFarlane Mining Company, Limited, owns mining claims J.S. 275, 276, 277, 278 and 280, also H.F. 305 and H.F. 306 in the township of Milner, situated west of Hewitt lake in the Gowganda area.

Shaft No. 1 was continued to a depth of 135 feet and abandoned. On the date of inspection, February 27th, 1917, shaft No. 2 on claim J.S. 280 was down 86 feet, with sinking in progress.

The plant included one upright 25 h.p. boiler, one portable loco type 60 h.p. boiler, one two-drill compressor, one 8 by 10 hoist, one 5 by 7 hoist.

The officers of the company are: President, C. H. Streit, Nutley, N.J.; secretary, Henry R. Crews; treasurer, Wm. J. McFarlane, manager, J. G. Wheaton, Gowganda P.O.; 25 men were employed on the last date of inspection.

Miller-Lake O'Brien.—This mine in the township of Nicol, owned by M. J. O'Brien of Renfrew, worked continuously throughout 1916. The company operates a hydro-electric power plant at the south end of Gowganda lake developing 800 h.p. from a 30-foot head. Shaft No. 1 is 90 feet deep, and shaft No. 2 or main shaft, 460 feet deep on an incline of 75 degrees. There are eight working levels at 60, 90, 140, 200, 240, 300, 350 and 450 feet. Work during the year was confined chiefly to development on the 350-foot level, where a high-grade vein was discovered in September, 1916.

The 10-stamp mill on the Millerett property was in operation during the year, but the Millerett mine was not working.

J. G. Dickenson, Cobalt, is manager, and B. C. Crowe, Gowganda, superintendent: 75 men are employed in the mine and mill.

Reeve-Dobie.—The Reeve-Dobie silver property on the Mann ridge west of Gowganda lake comprises claims S.W. 3, S.W. 4 and S.W. 5. These were

acquired in 1915 by the following syndicate: A. J. Skobba, Minneapolis, Minn.; Chas. Moore, Bay City, Mich.; F. C. Moore, Sudbury, Ont.; S. Christopherson, Gowganda.

Very little work was done during 1916. Some high-grade silver was taken from an open cut east of the power plant.

Work was in charge of S. Christopherson.

Lorrain and South Lorrain

Bellellen.—The syndicate operating the Bellellen on claim R.L. 470, South Lorrain, worked continuously throughout 1916. The winze on the 100-foot level about 100 feet south of No. 2 shaft was down 115 feet when inspected in November, 1916. About 75 feet of drifting was done at the bottom level. Shaft No. 1 is 70 feet deep with drifts to north and south at the bottom level. Work during the year was confined to No. 1 shaft. Following are members of the syndicate: Chas. Richardson, Haileybury, manager; R. T. Shillington, Arthur Ferland, J. H. Black, all of Haileybury.

Sylvester Carroll is mine manager, employing 5 men.

Comfort.—The Comfort Mining and Leasing Company operated the Wettlaufer property under lease from the Wettlaufer-Lorrain Mining Company. Work during the year was confined to milling of the fines in the dump and the jig tailings from previous milling operations. The tailings were hoisted on an incline and dumped into a raise near the mill, and trammed to the shaft on the 50-foot level.

A Hardinge ball mill, tables, trommels and settling tanks were added to the mill equipment. work was discontinued at the close of the year.

The directors of the company are: Dr. Comfort, Rochester, N.Y.; A. G. Kirby, Chas. Watson and Hector Bellingham.

Rex Taylor was superintendent, employing 15 men.

Currie.—The Pittsburgh-Lorrain syndicate worked the Currie mine on claim H.R. 105, South Lorrain, continuously during the year.

The shaft in the main workings is now 400 feet deep, and work during the year consisted of drifting on the fifth level and raising on the fourth. The winze workings from the fourth level were abandoned.

Shaft No. 2 is 110 feet deep, and 500 feet of drifting in the direction of No. 1 shaft was done during the year.

Thos. B. Rice, Silver Centre, is superintendent; and J. A. Rice, 208 Mills Building, El Paso, Texas, consulting engineer; 35 men were employed on the date of inspection November 12th, 1916.

Lorrain-Consolidated.—The Lorrain Consolidated Mining Company, formerly known as the Harris, continued development work at its property in South Lorrain during the year. Work was in charge of J. G. Harkness on contract; the shaft was sunk to a depth of 263 feet, and about 800 feet of drifting and cross-cutting done on the bottom level. It closed down on June 15, 1917. The compressor

at the adjoining property, owned by the Frontier Company, was used to supply air to the workings.

Jules Cohen is manager, employing 12 men.

Maple Mountain

Taylor.—On the Taylor claim, H.S. 571, south shore of McKenzie lake, Speight township, a small amount of work was done during the year. The shaft was timbered, and drifting resumed on the 150-foot level. The claim is owned by E. O. Taylor, 241 St. George St., Toronto, and underground work was in charge of L. Peterson, Elk Lake, under contract. The plant consists of one 25 h.p. upright boiler and one Napanee 5 by 7 hoist.

White Reserve.—The White Reserve Mining Company, Limited, continued the development of its claims in the Maple Mountain district. Several smaltite veins were discovered by surface trenching. In July, 1917, shaft No. 1 had reached a depth of 143 feet, and No. 2 on 21 vein was 90 feet deep. In No. 1 shaft, stations were cut at the 70-foot and 140-foot levels. On the 140-foot level, a cross-cut was run north to cut No. 21 vein and south to veins 9, 10 and 11. A total of 250 feet of drifting and cross-cutting was performed during the year.

The plant includes one 100 h.p. return tubular boiler, one 9-drill Rand compressor, one Ingersoll-Rand 10 by 12 hoist, shops, saw mill and camps.

The manager reports that in No. 21 vein considerable native silver is found in places, and that several samples across No. 14 vein have shown platinum content in the assays.

J. A. McAndrew, 408 Lumsden Building, Toronto, is president of the company; J. G. Harkness, Silver Centre, superintendent and consulting engineer; and Dan McCrimmon, foreman, employing 20 men.

IV.—EASTERN ONTARIO

Many branches of the mining industry in Eastern Ontario received a decided impetus in 1916. This was due entirely to war conditions. It is quite possible, however, that the increased trade may be retained when peace has been restored.

In the vicinity of Madoc several fluorspar prospects were developed and shipments made amounting to 1,284 tons. Small parcels had occasionally been sent out since 1914 from the Perry and Rogers lots, worked by Messrs. Cross and Wellington. Late in 1916, however, it developed that the Kentucky producers were unable to furnish any spar for export because of the increasing demands of the American steel trade. Canadian consumers immediately began to search for a supply at home, and early in 1917 the price had risen to $11 per ton. The fluorite veins near Madoc vary in width from 18 inches to six feet, and the material is a good average metallurgical grade.

It is estimated that Canadian furnaces consume about 15,000 tons per year, and further development may show that this demand can be supplied by Ontario producers.

During the year the Richardson feldspar quarry near Verona was sold, and a new company known as Feldspars, Limited, was organized which made extensive improvements with a view to increasing the output.

The iron mines of Eastern Ontario were idle during the year.

The Kingston Smelting Company was organized and work resumed at the lead smelter in Kingston, which has been idle for the past two years. Custom lead ores will be purchased, and an endeavor made to keep this plant in steady operation during 1917.

Iron Pyrites

Caldwell.—On lots 1 and 2 in the first concession of Blithfield township, Renfrew county, T. B. Caldwell of Lanark continued to operate his pyrites property. The incline shaft was deepened to 95 feet, and 35 feet of drifting done on the vein. Ten cars of ore were shipped to the Nichols Chemical Company, Sulphide. Since last report a small compressor and additional boiler capacity have been installed. Shipment was made from what is known locally as Clyde lake siding, on the C.P. railway about four miles north of Flower station.

Seventeen men were employed during the year. Mr. Caldwell is manager as well as owner of the mine.

Fowle.—On lots 6 and 10 in the tenth concession of Madoc township, J. C. Fowle of Madoc did considerable development work on a vein of iron pyrites, which outcrops on these lots. Some twenty-three test pits were sunk at various points. Mr. Fowle states that an average sample of the vein matter from sixteen pits ran 33 per cent. in sulphur.

Ten men were employed during the summer months.

Nichols Chemical Company.—The pyrites mine and chemical plant operated by the above company are situated at Sulphide in Hastings county, on lot 23, concession XI, township of Hungerford. The Nichols Chemical Company is a subsidiary of the General Chemical Company of New York.

Work underground during 1916 was confined to stoping on the first, second, third and fourth levels, chiefly west of the shaft. No sinking was done, and the shaft remains at 575 feet in depth.

The mine and plant were run to capacity during the year, because of the heavy demand for acids and other chemical compounds produced at the Sulphide works.

An interesting feature of the year's work was the success of the Sulphide plant in winning the inter-plant accident competition prize. This competition was carried on between sixteen plants operated by the General Chemical Company in the United States, and the Sulphide and Capelton plants in Canada. Out of a possible working time of 331,878 hours, the total lost time due to accidents was only 138 hours. The competition was carried on from March 1st to December 1st, 1916.

W. H. DeBlois is local manager, employing 35 men at the mine and 150 at the chemical plant.

Queensboro Mine. This mine near Queensboro in the township of Madoc, is owned and operated by the Canadian Sulphur Ore Company. Sinking was resumed in the main or No. 3 shaft, which had reached a depth of 350 feet at the close of the year. On the third level, the main drift had been carried 280 feet to a point directly under the surface showing, known as the No. 5 ore body. No. 2 shaft was pumped out, and will be sunk to the 200-foot level, and the workings connected with No. 3. The plant has been enlarged, and a second compressor installed giving sufficient power for all development work.

A switching engine for handling cars between the mine and the main line of the Canadian Northern was purchased during the year.

The officers of the company are: Alex. Longwell, Toronto, president; Geo. H. Gillespie, Madoc, manager; H. F. Smeaton, Queensboro, superintendent. Sixty men were employed during the year.

Copper

Cashel Copper Mines, Limited. This company was incorporated in March, 1916, and acquired the east half of lot 31, and the south 20 acres of the west half of lot 31, in all 76 acres, in the first concession of Cashel township, Hastings county.

Work was begun about September 1st, and on the date of inspection in December, 1916, a vertical shaft 5 feet 6 inches by 10 feet 6 inches had been sunk to a depth of 50 feet. The shaft was on a vein containing chalcopyrite. No shipments had been made, but a small quantity of hand-picked vein material was on the dump.

C. S. Crysler is president and manager; W. Younger, vice-president; E. W. Storer, treasurer; S. B. Dawson, secretary.

Twenty men were employed in sinking by hand, under the direction of Mr. Crysler.

Gold

Cordova.—Work during the year at Cordova mines was confined chiefly to the completion of the surface plant. Late in the year pumping was begun in No. 1 and No. 3 shafts, and a little mining done above the 100-foot level in No. 1 shaft. The power plant and dam on Deer Lake were completed, and it was found that during the summer months the water supply would prove insufficient. In order to keep up the normal supply of water, at least three conservation dams are needed, one each at Whetstone, Loon and Pandash lakes. With these in place it has been estimated that the turbines could be operated to capacity the year round. It was the intention of the management to carry on active mining operations during 1917, but a disastrous fire on March 13, 1917, destroyed the shaft house, and crushing plant, 30-stamp mill, water tanks, blacksmith and machine shops, trestles over conveyors and in fact all the surface equipment at No. 1 shaft. The new compressor plant, office and laboratory were saved. This will delay operations for some time.

Peter Kirkegaard is managing director of the company, and S. H. Brockenier was appointed manager a short time before the fire. Thirty-five men were employed.

Cobalt-Frontenac Mining Company, Limited.—Mining rights owned by this company in eastern Ontario include the following properties:—

Lots 24 and 25, concession VI, township of Kaladar, known and described in previous reports as the Golden Fleece mine.

North half of lot 26, and the southwest quarter of lot 27, concession VII, township of Kaladar, and lot 33, concession I, township of Barrie.

Very little mining work was done during 1916. No. 2 shaft was re-timbered, and sunk to a depth of 60 feet. About 300 tons of ore were mined from the open pit near the mill, and put through the stamps.

On the Scootamatta river, near the village of Flinton, the company purchased a saw mill plant and water power, which will be developed as a source of electrical energy for the Golden Fleece mine. During 1916 a concrete dam 127 feet in length was built, and at this point a head of 22 feet is obtained.

It was expected that power would be turned on in August, 1917, but non-delivery of plant will prevent completion when expected. The foundation has been blasted for the installation of a Kennedy horizontal turbine.

The officers of the company are: George W. Millen, president, Hamilton; M. G. Notz, secretary-treasurer, Hamilton; M. D. H. Fletcher, managing director, Hamilton; Ernest Craig, superintendent, Flinton.

The head office is at 501 Bank of Hamilton Chambers, Hamilton, Ontario.

Ten men were employed during the year, chiefly on construction work.

Ore Chimney.—Underground work at the mine operated by the Ore Chimney Mining Company near Northbrook, in Barrie township, Frontenac county, was resumed 8th August, 1916, having been discontinued December 25th, 1915. On the date of inspection, April 9th, 1917, the development was as follows:—

Shaft, depth 405 feet.

First level at 108 feet, east drift 17 feet, south drift 6 feet and cross-cut 25 feet.

Second level at 150 feet, north drift 127 feet, south drift 79 feet, total cross-cutting 78 feet.

Third level, at 250 feet, north drift 83 feet, south drift 100 feet, total cross-cutting 237 feet.

Fourth level at 300 feet, cross-cutting 31 feet.

Fifth level at 332 feet, cross-cutting 41 feet.

Sixth level at 400 feet, cross-cutting 62 feet, north drift 20 feet, south drift 20 feet. A raise has been begun in the south drift 55 feet east of the shaft. This raise will be carried through to the surface and will serve as an auxiliary shaft.

Since last report a third boiler has been installed, there now being a battery of three boilers with a total of 280 h.p. A second Laidlaw-Dunn-Gordon compressor has been purchased from the Golden Fleece company. This is a duplicate of the machine now being used, and has a capacity of 520 cubic feet.

At the mill the following additions to the plant were installed during the year: one set of Buchanan rolls 14 in. by 24 in.; two revolving screens 6 feet by 30 in.; four automatic ore feeders; four Wilfly tables; one Sturtevant jaw crusher, 8 in. by 24 in.; one roasting kiln 5 feet by 30 feet.

There were no ore shipments during the year.

The officers of the company are: Anson E. Fletcher, president, Hamilton; O. E. Dores, secretary-treasurer, Hamilton; W. G. Anderson, manager, Northbrook. Twenty-five men were employed during the year.

Talc

Connolly Mine. This mine, situated near the village of Madoc adjoining the Henderson mine on the east, is owned and operated by the Anglo-American Talc Corporation, Limited.

Owing to non-delivery of machinery, the mill was not completed during the year, and very little work was done underground. The shaft remains at the same level as at last report, 140 feet, and on the date of inspection, February, 1917, work had been resumed underground and drifting begun east and west on the 125-foot level. Part of the necessary machinery was in place in the mill, including one No. 3 Gates crusher, one Griffin pulverizer, and one tube mill 5 by 24 feet. Hydro-electric power is used to operate the compressor and mill machinery. The officers of the company are H. S. Predmore, president, New York; R. J. Gilchrist, secretary, New York; Thomas Carswell, superintendent, Madoc. Twelve men were employed in the mine and mill.

Eldorite, Limited.—Work was resumed on this property early in 1916 under the management of A. E. Millington. The mine and mill formerly owned by the Canadian Talc and Silica Company, are situated near Eldorado station on the Central Ontario railway. Shaft No. 1 is 65 feet deep, and No. 2, 15 feet. A new ore body was being worked west of No. 1 shaft, showing fairly good talc. This shoot was 25 feet wide, and at the working face was 35 feet to the back of the stope. During the year the mill machinery was changed to meet modern requirements. Shipments were made steadily until October, when both mine and mill were closed.

The officers of the company are: Sir Douglas Haig, president; P. H. Morton, acting president; J. A. Haig, managing director; E. Kempster, secretary, all of London, England. Fifteen men were employed during the summer.

George H. Gillespie and Company. The talc grinding plant operated by this company is situated near the Grand Trunk station, in the village of Madoc. During the year a third tube mill was installed, also a new jaw crusher and six bolting machines. This installation greatly increases the capacity of the plant.

All of the ore ground came from the Henderson mine operated by Cross and Wellington.

Eighteen men were employed in the mill during the year.

Henderson Mine.—This mine near the village of Madoc in Hastings county is operated under lease by Messrs. Cross and Wellington.

The caving system started in 1911 has worked satisfactorily, and a force of 8 men produce an average of 1,100 tons per month. Work during the year was practically confined to the first level, slicing caved material between No. 1 and No. 4 raise.

About 90 per cent. of the output goes to the Gillespie grinding plant, and the balance is supplied to the trade as mine-run ore.

Mr. Stephen Wellington is manager of the mine.

Fluorite

Cross and Wellington. The most extensive development has been done by the above firm on lot 11 in the thirteenth concession of Huntingdon township, on what is known locally as the Perry lot, from the name of the original owner.

On this lot two shafts have been sunk. No. 1 shaft was abandoned at a depth of 68 feet, and No. 2 shaft had been sunk to a depth of 55 feet on the date of inspection in February, 1917. At the bottom of No. 2 shaft the vein was five feet in width.

Near the shore of Hog lake, on the same lot, a small portable plant was installed, and considerable ore shipped from an open cut on an outcrop of spar which averaged 5 feet in width. The open pit measured 73 feet long, by 5 feet wide, by 15 feet deep. At this depth the water was increasing in volume, and work had to be stopped till a pumping plant could be installed.

Mr. Stephen Wellington is manager, employing ten men.

Hungerford Syndicate.—On lot 1 in the fourth concession of the township of Madoc, the above company began operations on a fluorite deposit late in 1916.

A small plant was installed, consisting of one portable locomotive 50 h.p. boiler, one small two-drill compressor, and a single drum Mac Machine Company hoist. The vein outcropped within a few feet of the farm owner's residence, and a shaft was sunk on the outcrop. On the date of inspection February 6th, 1917, the shaft had reached a depth of 25 feet and about 60 tons of clean crystalline spar had been stock-piled.

Robert Phillips was in charge of operations for the owners, Messrs. Harry Hungerford and Robert Gilchrist. Twelve men were employed.

Mineral Products, Limited.—On the McIlroy farm, lot 2, concession IV, township of Madoc, C. R. Ross and associates did considerable work on a fluorite occurrence, which may develop into a steady shipper. The vein had an average width of 30 inches, and the vein matter is almost pure fluorite. This has been removed by open-cut method for a distance of 200 feet, the deepest workings being 50 feet. At this point a shaft was sunk and development continued.

On the date of inspection, February 6th, 1917, the organization of the company had not been completed, but the officers included Messrs. G. S. Weyman and Charles H. Dearborn of Boston, Mass.; and R. R. Casement, Madoc, with Charles R. Ross, Madoc, as manager.

Seven men were employed on the date of inspection.

Wellington and Munro. On lot 13, concession XII, township of Huntington, the above firm did considerable work on a feldspar deposit. This occurrence is across Hog lake from the Perry lot, and with further development may prove to be a consistent shipper. The vein had an average width of five feet, and ore was being removed from two open pits, one 15 feet long by 20 feet deep, and

the other 50 feet long by 20 feet deep, both six feet wide. The ore was hoisted by means of a horse whim and a small derrick. A short distance from the two pits on which work was in progress, a third outcrop was found which showed ore for a width of 8 feet.

On the east half of lot 1, in the first concession of Madoc township, on the Lee farm, Messrs. Wellington and Munro did a small amount of work on a vein having an average width of 30 inches. One car of high grade spar was shipped from this lot, and a second car was ready for shipment. Work was discontinued on the date of inspection February 7th, 1917, till a pumping plant could be installed.

Stephen Wellington is manager, employing 15 men.

Lead

Galetta. The Galetta lead mine and smelter are situated on Chats island, lot 22, concession VI, township of Fitzroy. During 1916, the ore above the first level at 100 feet was stoped out, a winze sunk to the 185-foot level, and 170 feet of drifting done.

The concentrating plant on the date of inspection in March, 1917, was handling about 30 tons of ore per day, and making two grades of concentrates. The first, a clean galena, is sent to the smelter, and the second, a galena-zinc mixture, is stock-piled for further treatment.

During the year the smelting plant was completed and put in operation. It is said to have a capacity of 18 tons of pig lead per 24 hours.

The property is owned and managed by the Estate of James Robertson, Montreal. Sixty-five men were employed during the year.

Indian Lake Lead Mining Company. This company was organized in 1916 to take over the Frontenac lead mine near Perth road in Frontenac county. No work was done in the mine during the year. Some changes were made in the mill, and it is possible that the mine will be pumped out and operations resumed in 1917.

Mark J. Paterson was in charge of work for the new company.

Heck and Drummond.—On lot 17 in the sixth concession of the township of Bedford, the above firm did a small amount of development work on a lead prospect during the summer of 1916. Work was commenced in July and continued for some months. Several test pits were sunk along the strike of the vein, and in places some rich pay streaks of galena were uncovered. The ore appeared to be a fairly clean galena in a calcite gangue, and from one pit a carload of hand-picked ore was shipped to Perth Amboy. All work was done by hand, no plant having been installed on the date of inspection in December, 1916.

Seven men were employed under the direction of George Heck, of Prescott. Interested with Mr. Heck in this prospect, are Messrs. F. P. Drummond of Burridge, Ontario, and J. H. Drummond of New York.

Feldspar

Feldspars, Limited.—This company was organized early in 1916, and purchased the Richardson properties near Verona in Frontenac county. Included in the sale were the Reynolds and Desert lake quarries, where most of the spar produced in Ontario was obtained. The Kingston Feldspar and Mining Company retained the Card quarry, which at one time was a steady shipper of feldspar, but has been closed for the past six years. This will probably be re-opened as a source of silica rock, for which there is an increasing demand.

Extensive changes have been made at the Desert lake mine by the new management. Heretofore, the spar has been taken from an open pit, which in the course of many years' operations has assumed large proportions. It is now 350 feet long by 100 feet wide, and in places 100 feet deep. It is the intention of the new management to sink a shaft at some point in the wall rock near the south end of the pit, and hoist all material through this shaft, thus doing away with the derrick and open bucket system. New boarding camps have been built to replace the buildings in use, which were situated too close to the pit for safety. It is possible also that in 1917, an aerial tram will be installed to carry the ore to the track, instead of transporting it in scows over 30-Island and 13-Island lakes to Glendower siding.

The officers of the company are: S. Harry Worth, president; W. E. Segsworth, managing director; R. F. Segsworth, secretary-treasurer; J. Ralph Scott, superintendent. Fifty men were employed during the year.

Feldspar Quarries, Limited.—This company was organized in 1916 by Messrs. Frank and George Hurlburt, to work the feldspar property in Loughborough township described in the Bureau's 25th annual report under the title Hurlburt prospect. This prospect was abandoned early in the year, and the prospect on the Reynolds farm in the 10th concession of Portland township purchased from the Canadian Feldspar Corporation.

This property was a steady shipper of high-grade spar during 1916. At the close of the year the open pit was 120 feet long by 65 feet wide by 70 feet deep.

The plant consists of two upright boilers, 25 h.p. each, one Napanee hoist, and one guyed derrick with 40-foot boom. Steam is used for drilling, and the rock is hand-picked in the pit. Late in the year the above company purchased the feldspar grinding plant near Parham station from the Dominion Feldspar Company.

The plant was repaired but no spar was ground in 1916. It is the intention to grind at this plant the output of the company's quarry, and also purchase any custom ores that may be offered.

George Hurlburt is manager of the quarry and mill employing 15 men.

Sidney H. Orser.—On lots 12 and 13 in the sixth concession of the township of South Sherbrooke, S. H. Orser of Perth quarried feldspar during the year. This deposit was originally owned by Rinaldo McConnell, who did a small amount of work some years ago. On the date of inspection September 27th, 1916, Mr. Orser employed 10 men, and work was being pushed vigorously to fill

a contract. The pit was 20 feet wide, and good spar had been stripped for a distance of 100 feet along the dike.[1]

Shipment was made from Maberley station, C.P. railway a distance of three miles from the quarry.

Work was discontinued 21st December, 1916, and the quarry leased to H. N. Kraft. During the year this pit produced 2,000 tons of feldspar.

On lot 17 in the sixth concession of South Sherbrooke township, the Patterson farm, Mr. Orser took an option and did some development work. A small amount of feldspar was quarried and hauled to Maberley for shipment.

Victoria Feldspar Quarry. This quarry, on lot 33 and the north half of lot 32, in the third concession of Bedford township, was working for a short time only in 1916. Early in the year it was the intention of the owners Messrs. J. M. Stoness and Sons to actively develop the property and if conditions warranted it, to build a grinding plant at the quarry. These plans were changed on the death of the principal owner, J. M. Stoness.

The quarry is well located for shipping purposes, as the C.P. railway runs directly through the property. It is situated about three miles west of Crow lake station on the Lake Shore line of the C.P. railway.

Mica

Anglin.—The Anglin Mica Mining Company, Limited, continued to develop its property near Gould lake, on lot 10 in the tenth concession of Loughborough township. The workings on the date of inspection in January, 1917, consisted of a series of open pits, the deepest one being 60 feet. The mica occurs in pockets, and wherever the gangue appears favourable an opening is made and abandoned when the mica is not found in paying quantities. This system appears to be general in mica mining, with the one exception of the Lacey mine at Sydenham, where the crystals are found at depth, and the veins have been worked for many years. The plant at the Anglin mine consists of one portable locomotive boiler, two derricks and a steam drill.

S. Anglin, Kingston, is president of the company; F. R. Anglin, secretary; and J. E. Anglin, manager. Fifty men were employed during the summer months.

Buck Lake.—A mica prospect was opened during the year by the Buck Lake Mining Company on lot 22, in the eleventh concession of Loughborough township.

A narrow vein was followed down on an incline to a depth of 65 feet, and considerable mica removed. The plant included one small stiff-leg derrick and horse whim.

Alex. Watson, Fairmont, West Virginia, is president of the company, and work during the summer was in charge of Henry McCadden, Perth road. Four men were employed.

Lacey Mine.—The Lacey mine near the village of Sydenham in Loughborough township is owned and operated by the General Electric Company. It is the

[1] This is the quarry in which the mineral euxenite was found, described in the present volume by Dr. W. G. Miller and Cyril W. Knight.

largest producer of mica in the Province, and is said to be the largest in the world.

During the summer months, work was resumed in the open pit; in the winter the mica is obtained chiefly from the stope in the milky vein. The mica is shipped rough-cobbed to the trimming and splitting plant operated by the company at Ottawa. The Canadian operating company is known as the Loughborough Mining Company.

George W. McNaughton is manager of the company, and Henry Smith, mine superintendent. Fifteen men are employed at the mine.

Silvey H. Orser Mica Company.—On lot 6, in the eighth concession of Burgess township, this company continued to develop the mica property formerly known as the Burns mine. Several new veins were discovered, but no pits or workings of a permanent nature were developed. The mine was closed on November 15th, 1916, and work discontinued for the winter months. Four men were employed during the summer months. A considerable quantity of mica was taken out and teamed to the cleaning house operated by the company at Perth. Mr. Orser has taken an option on a new discovery of mica near Bolingbrooke station, C.P. railway, in the township of South Sherbrooke, and intends to develop this spring 1917.

Average prices received for mica during the year were higher than in 1915. The several sizes sold per pound as follows:—

1 x 1	6 cents	2 x 4	60 cents
1 x 2	11 "	3 x 5	$1.00
1 x 3	17 "	4 x 6	$1.30
2 x 3	40 "		

The smaller sizes were again in good demand.

Kent Bros.—This firm, with headquarters at Kingston, has been active for a number of years in the mining and marketing of mica. They are the chief owners of the Taggart mine on the west shore of Bob's lake in Bedford township, which was worked with a small force during 1916. On lots 2 and 3 in the first concession of Burgess township, mica was mined from several pits with a force of three men under foreman J. W. Silver. This property is owned outright by Messrs. Kent Bros., and in the early days of eastern Ontario mining was a large producer of phosphate. The pits run from 10 to 40 feet in depth.

On lot 4 in Bedford township near Buck lake, four men were employed all summer in mining mica, in various pits and old openings. All of the mica is rough-cobbed at the mines, and shipped to Kingston where it is finished, trimmed and split for the market.

Sydenham Mica and Phosphate Mining Co.—On lot 7, in the eighth concession of Loughborough township, this company built substantial camps, and began operations on a promising mica prospect in the fall of 1916. No shipment had been made up to the date of inspection in December, 1916, but a plant was being installed and arrangements made for a cleaning house in Sydenham village.

H. N. Kraft is in charge of operations, employing seven men.

Trimming and Splitting Plants. The following firms are engaged in trimming and thin-splitting mica: At Ottawa, Loughborough Mining Company, Laurentide Mica Company, S. O. Fillion, Eugene Munsell and Company, and R. Blackburn; and at Kingston, the Anglin Mica Mining Company and Kent Bros.

Molybdenite

In the twenty-fifth annual report of the Bureau of Mines a fairly complete description is given of the known occurrences of molybdenite on which work had been performed. During 1916 some of the prospects mentioned in this report were sold, and on many of them no work was done. The assets of the Orillia Molybdenum Company were taken over by the International Molybdenum Company. The new company being a merger of the Orillia and O'Brien interests, including the O'Brien molybdenite mine, the smelter at Orillia, and the concentrating plant at Renfrew.

The Legree prospect on lots 35 and 36 in the fourteenth concession of Brougham township was reported sold to a New York company known as the Steel Alloys Corporation, and very little work was performed during the year.

Chisholm Mine.—This property on lot 5, concession XIV, Sheffield township, was described in the 25th annual report under the title Sheffield mine. The name has since been changed to the Chisholm mine from the name of the owner. Early in the year it was under option to the International Molybdenum Company, but the option was never exercised, and the property reverted to A. M. Chisholm, the original owner. A small mill was built, and a low-grade concentrate was produced and shipped to Ottawa for further treatment. The plant consisted of one Sawyer-Massey jaw crusher, two sets of 10 by 16 rolls, followed by two Sturtevant screens, the oversize from the screens being returned to the rolls. By this process it was claimed that a 15 per cent. shipping product was obtained.

Twelve men were employed by Mr. Chisholm, who was in charge of all work at the property.

International Molybdenum Company.—This company was organized in 1916 by G. P. Grant of the Orillia Molybdenum Company. Options were taken on various prospects including the Jamieson in Lyndoch township, the Chisholm in Sheffield township, the Moran prospect adjoining the O'Brien mine, and others in Quebec and British Columbia. In the town of Renfrew a suitable building was secured and a concentrating plant installed, to which the ore from the several properties could be taken for treatment before shipment to the smelter at Orillia.

The Chisholm and Jamieson prospects reverted to the original owners, and most of the ore received at the Renfrew plant was shipped from the O'Brien mine in Brougham township. This mine was worked up to 22nd December, 1916. Since that date all work was done on the property adjoining the O'Brien, known first as the Moran prospect, later sold to the Ross Syndicate of Ottawa, and in the spring of 1916 leased by this syndicate to Frank G. Todd of Montreal, who in turn leased it to the International Company. A vertical shaft had been sunk to a depth of 26 feet on the date of inspection in January, 1917, and several

open cuts made on promising veins. The plant at the mine included two portable locomotive boilers, one Jenckes hoist, one Smart-Turner pump, two derricks, and seven machine drills. Substantial boarding camps, office and shops have been erected on the property.

The mill at Renfrew is designed to treat ore from the company mines, and any custom ore offering. The concentrates from the mill are shipped to the smelter at Orillia, where molybdic acid and ferro-molybdenum are manufactured.

The officers of the company are: J. L. Murray, Renfrew, president; H. A. Jordan, Renfrew, secretary; G. P. Grant, Orillia, managing director, and J. F. McKenzie, mine superintendent.

Twenty men are employed at the O'Brien mine and 15 men at the Renfrew mill. This force does not include the teamsters hauling to Ashdod station from the mine, or the office staff at the mill.

Renfrew Molybdenum Mines, Limited. This company was actively engaged during the year in the mining and concentrating of molybdenum on their property lots 8 and 9, concession XI, township of Brougham.

Exploration was carried on by shot drills, and a two-compartment shaft sunk to a depth of 83 feet, with three working levels. A complete mining plant was installed consisting of two Jenckes locomotive type boilers, 60 h.p. each, one Rand compressor, capacity 585 cubic feet; one 6 by 8 Jenckes hoist, and laboratory.

About July 1st, work was begun on the foundation for the concentrator, which was completed and running before the close of the year. The ore is first broken in a Farrell jaw crusher, then fed direct to a Hardinge ball mill, the feed being controlled by a Challenge feeder. From the ball mill it passes to a concave sizer. The oversize from this screening operation is returned to the ball mill, and the undersize to settling tanks, mixers, and then direct to an Elmore vacuum oil unit, where concentration is completed. The Elmore unit has a capacity of 35 tons per day, and the oil used is a crude kerosene costing about 5 cents per ton of ore treated. It is claimed for this process that an extraction of 95 per cent. is obtained, and the concentrate is exceptionally high-grade, running from 90 per cent. upward in molybdenum content.

At the time of inspection, January 25th, 1917, adjustments were being made on the plant, and it was not yet running to capacity. About 300 lbs. per day of concentrate was being produced for shipment to France.

The officers of the company are: Jean Vanophen, Brussels, Belgium, president; R. Leprohon, Grand Mere, Quebec, secretary; P. C. Neault, Grand Mere, Quebec, treasurer; and Charles Spearman, Mt. St. Patrick, manager; 65 men were employed in the mine, mill and surface development work.

Spain. The Spain mine, so called from the name of the owner William J. Spain of New York, is situated on lot 31, in the fourth concession of the township of Griffith. Production was not very steady during 1916, the first six months being taken up in the erection of the concentrator mentioned in the Bureau's 25th annual report. The first mill run was made on June 22nd, but it was shut down for adjustments when inspected on June 29th.

The plant installed, follows closely the original design described in the 25th annual report.

Work during the year was under the supervision of Michael Fogarty of New York.

Graphite

Black Donald.—The Black Donald Graphite Company continued to be the largest producer of graphite in the Province. The mine and mill are situated about 11 miles from Calabogie, in Renfrew county. The mining rights of the company include lots 17 to 20 inclusive, in concessions 1, 2 and 3, township of Brougham.

To meet the increased demand, the mine was worked all winter in 1915-16, whereas heretofore mining operations have been suspended during the winter months.

In March, 1916, a new shaft was sunk near the old workings. This shaft had reached a depth of 57 feet at the close of the year, and was producing about 25 tons per day of ore equal in grade to the average product of the old workings.

In 1916 a considerable quantity of Ceylon and Corea graphite was marketed in America, chiefly the very highest grade for crucible stock only. The stimulus given to the trade during the past two years is due entirely to war conditions. The interruption to shipping, both from Ceylon and Senora, Mexico, called for an increased production from the mines in Canada and United States. In the state of Alabama alone, fifteen new properties were opened during the year. Under ordinary conditions these mills alone would produce all the trade could absorb. The price rose for No. 1 flake from 6 cents per pound to 12 cents in 1916.

Seventy-five men were employed at the mine and mill under superintendent J. G. Patno.

The officers of the company are: A. M. Munger, Kansas City, president; R. F. Bunting, Calabogie, general manager and treasurer; J. N. Snead, Calabogie, secretary.

Globe.—On August 12th, 1916, the assets of the Globe Graphite Mining and Refining Company were sold by the chief owner, Rinaldo McConnell, to a group of capitalists from Syracuse, New York, who continued to operate under the above company name.

The mine is situated on lots 21 to 23 inclusive, in the sixth concession, township of North Elmsley, and the ore is teamed to the mill at Port Elmsley, a distance of three miles.

Under the direction of the owners, a contract was given Messrs. Smith and Durkee of Sudbury for several hundred feet of diamond drilling. The mill was enlarged, and the process of refining changed to meet modern conditions and increase the capacity. At the mine two shafts were begun. No. 2, incline, was down 20 feet, and No. 3 vertical, 42 feet, on the date of inspection in February, 1917.

Additional plant at the mine included one compressor with a capacity of 300 cubic feet, one portable locomotive boiler, 60 h.p., one return tubular boiler, 80 h.p., one double drum Lidgerwood hoist.

The officers of the company are: Charles A. Lux, Syracuse, president; George G. Fryer, Syracuse, secretary; George H. Beebe, Pt. Elmsley, manager; George N. Brower, Pt. Elmsley, superintendent. Thirty-five men were employed at the mine and 12 at the mill.

National. The National Graphite Company, Limited, continued development on its property, lot 24, concession XIII, township of Monteagle.

The No. 1 shaft or pit, described in the last annual report, supplied most of the ore mined by the company during 1916, and at the close of the year this shaft was 125 feet deep. Pit No. 2 was 40 feet deep, and pit No 3, 20 feet deep. Work now in progress will connect pits 1 and 2, at the 125-foot level. The mine is situated near the village of Maynooth on the Canadian Northern railway, and during the year a boiler and compressor plant was erected near the track about 1,000 feet from the mine. This installation consists of one 16 feet by 72 inches, return tubular Goldie McCulloch boiler, 150 h.p., and one Rand compressor, capacity 2,000 cubic feet of free air per minute.

The new plant had not been put in commission up to 11th April, 1917, power being still supplied by the small 315-foot Rand compressor at No. 1 shaft.

The last shipment of ore to the Harcourt mill was made 20th December, 1916, and since that date all ore has been stock-piled at the mine. Manager Foster stated that a re-organization of the company was in progress, and it was probable that during 1917 the mill at Harcourt would be dismantled and moved to the mine at Maynooth.

Finished flake graphite to the extent of 900,000 pounds was shipped during 1916. The lower grades are in demand as foundry facings, and all the No. 1 product went to the crucible manufacturers, with the exception of a shipment of 50 barrels of No. 1, which went to a munitions factory in France. The officers of the company are: W A. P. Schurman, president and treasurer, Toronto; R. W. Foster, manager, Maynooth; W. H. Matthews, director, Toronto.

Twenty-five men were employed at the mine and 12 at the Harcourt mine.

Corundum

The Manufacturers' Corundum Company, Limited, resumed operations at the Burgess property 15th April, 1916, and closed down 1st August, 1916. In the meantime prospecting and development was continued on properties acquired by the company in the townships of Raglan and Radcliffe, and in August the Burgess mill was dismantled and moved to Palmer rapids in Raglan township. At this point a new mill was erected, to treat the ores mined on the following properties:—lot 32, concession 1, township of Radcliffe; lots 25 to 28 inclusive, concession 19, township of Raglan; lot 24, concession 18, township of Raglan. On this latter lot the mill is situated.

The mill has a capacity of 100 tons per day, and the method of treatment varies greatly from that previously employed at Burgess and Craigmont. A leading feature of the milling practice is in the classification of the Wilfley table feed, resulting in a much higher grade shipping product.

As noted in previous reports, the ore deposits are very shallow, and can be worked by the open pit method. As a result, work is being carried on at several places at the same time and portable thaw houses, fuse and cap houses and boiler plants have to be employed. The ore is teamed to the mill from the various pits, in some places a distance of four miles.

The officers of the company are: D. A. Brebner, 58 King St. East, Toronto, managing director; A. W. Holmsted, secretary, Toronto; Prof. H. E. T. Haultain, consulting engineer, Toronto; E. B. Clarke, superintendent, Jewelville, P.O.

Seventy men were employed during the year.

Quarries

Canada Cement Company. The quarry operated by this company to supply stone to its No. 5 plant at Point Anne near Belleville, was opened for the year's operations in May, 1916, having been closed for some time previous. From May till the close of the year, it was worked continuously, and on account of the activity in the cement trade, it will be kept open throughout the winter of 1916-17.

A Clipper churn drill is used, and a large quantity of rock is always kept broken ahead of requirements. Holes are drilled 24 feet deep and 5 and 6 inches in diameter

H. L. Shook is manager, employing 35 men in the quarry.

Point Anne. Point Anne Quarries, Limited, situated about one-half mile west of the Canada Cement plant, worked to capacity throughout the year 1916. The quarry is now one-half mile long by 100 feet wide, and has an average depth of 30 feet. Drilling is done with an Armstrong electric well drill, and the broken rock is loaded by steam shovel. In addition to the regular output of crushed stone of all sizes, shipped by lake and rail, 10,000 tons of crib-filling was supplied to Toronto. One No. 18 McCully crusher was added to the plant during the year.

The officers of the company are: M. J. Haney, president; J. F. M. Stewart, manager; A. N. Harnwell, secretary-treasurer; A. G. Bennett, superintendent.

Twenty-six men were employed during the year.

Hastings Quarry Company.—On lot 11 in the fourteenth concession of Hungerford township, the quarry owned by this company was operated for two months from 15th September to 15th November, 1916. A special order for crushed red granite was being filled for use at the Bloor Street Viaduct, Toronto, and on the completion of this contract the quarry closed. The rock is loaded from bins to cars on C.N. railway siding from Bridgewater.

John Grant is manager of the quarry, which had been shut down for the previous two years, and the steam plant utilized for the operation of a saw-mill on the quarry property.

For various reasons, mainly arising out of the war, which manifested themselves in slack demand by the building trade, and small appropriations by townships for road work and other municipal demands, a large number of the quarries described in previous reports of the Bureau were closed entirely or worked for

short periods only during 1916. This condition will probably continue during 1917 and to the close of the war. A few were opened for two months to fill special contracts, such as the Hastings quarry, others for a longer or even shorter period. For this reason, and the fact that many were closed entirely when visited by the Inspector no attempt is made to describe these quarries fully.

V.—SOUTHWESTERN ONTARIO

The remarks made regarding quarries in eastern Ontario apply also to those of southwestern Ontario, with the exception of quarries operated for the production of white lime. The demand for this product is fairly steady and increasing, with a tendency on the part of producers to erect hydrating plants to supply the large Canadian demand. It is possible that in a few years the imports of hydrated lime, chiefly from the Ohio plants, will cease entirely, and the whole Canadian trade will be supplied from Ontario plants. The limestone in the vicinity of Teeswater and Elora has been found to be particularly suitable for hydrating purposes.

Quarries

Boyd.—On lot 3 in the fourth concession of Nassagawaya township, the Boyd Pressed Brick Company operates a quarry in the Medina shales for the manufacture of pressed brick. The quarry has a working face 25 feet high, and this is operated in two benches.

George Lamb, Milton, is manager of the company, employing 10 men in the quarry.

Canada Cement Company.—This company's quarry and plant at Port Colborne, shut down 21st January, 1916, was re-opened 5th April, and ran continuously till the close of the year. In the quarry a 20-foot face is being worked, just north of the Grand Trunk right of way. Part of the stone is being removed from the Reeb property, on which a royalty is paid, and part from the company's own quarry.

Drilling is done by two Clipper churn drills, drilling 5-inch holes, and block-holding by plugger drills, for which air is supplied by a small Westinghouse air pump. This is a portable outfit, and works efficiently if the air line is kept under 50 feet.

S. R. Preston is manager, employing 25 men.

Canada Crushed Stone Corporation, Limited.—The quarry and crushing plant of this company near Dundas in the township of West Flamborough, was in continuous operation throughout the year. A complete description of the quarry and plant was given in the last annual report of the Bureau. In this report was included also an average analysis of the limestone, and the several uses for which it is suitable.

The quarry employs an average of 45 men and the crushing plant 15. C. M. Doolittle is president and general manager of the company, and J. B. Hart secretary-treasurer and assistant manager.

Cataract Sand and Gravel Company. One of the largest sand and gravel pits in the Province is situated at Cataract Junction on lot 14 in the third concession of Caledon township.

The working face has a depth of 125 feet measured on the incline. The top layer is a coarse gravel, and the bottom bed is composed of finer gravel with clean sand between the two gravel beds. In the summer of 1916 a plant was being installed to strip the upper bed of coarse gravel, and thus work the pit in benches, doing away with the screening plants. A clam shell hoist and hopper was erected on the upper bank, and the material loaded directly into cars below, through a chute 120 feet in length. By this arrangement it will be possible to extract the 20 feet of clean sand without screening.

The pit was purchased by the Hydro-electric Commission in the spring of 1916, and work was under the direction of Chief Engineer F. A. Gaby.

W. A. Alexander, Alton, was superintendent, employing six men.

Coast and Lakes Contracting Corporation. The head office of this company is at 11 Broad St., New York City, and eleven quarries are operated in various states in the Union. The company's Canadian quarry is situated in the township of Bertie, Lincoln county, about six miles from the village of Ridgeway. During 1916, operations were restricted, and only two cargoes of the large blocks for breakwater purposes were shipped to Buffalo. In addition to this, fifteen cars of rubble were shipped to local Canadian points.

The quarry closed in August, 1916.

H. L. Clapham is superintendent, employing 10 men.

Constructing and Paving Company.—In the township of Erin about two miles northeast of the village of that name, this company operates a large sand and gravel pit. The material is dug by a Beatty clam shell hoist and loaded into dump cars, capacity five cubic yards each. These are hauled on the level to a hopper, and fed directly to a No. 3 Austin gyratory crusher. From the crusher it is elevated to a revolving screen 14 feet long by 3 feet in diameter, constructed in two sections, 10 feet of sand screen and four feet of gravel. This gives two products, sand and gravel. The crushed boulders are not separated. At this plant there is also machinery for manufacturing sand-cement tile. These are made 12 inches long and 3, 4 and 5 inches in diameter.

The officers of the company are: James Pearson, Confederation Life Building, Toronto, president; F. B. Neave, Toronto, secretary-treasurer; W. E. Bristow, superintendent; 6 men are employed.

Contractors' Supply Company.—On lot 27, concession 1, Caledon township, near the town of Orangeville, this company quarries limestone for the burning of lime, a small portion of the product being sold as crushed stone. The quarry has a working face of 23 feet, and is 150 feet long by 100 feet wide. There are two draft kilns with a capacity of ten tons of lime each per day. In August, 1914, a plant for the production of hydrated lime was built. The stone in this quarry yields a gray lime only, and in order to compete with the white lime producers, a

second quarry was purchased at Teeswater, Bruce county, and stone from that point shipped to the hydrating plant. In this way both white and gray hydrated lime are manufactured.

The lime from the kilns is first crushed in rolls and conveyed to a bin above the mixer on a belt conveyor. In the mixer or hydrator, 60 gallons of water is added to each ton of lime, through a perforated pipe, and the whole mass rotated until the hydration is completed. It is then screened and bagged for the market.

The plant consists of two horizontal tubular boilers, one jaw crusher, one Simons disc crusher, rolls, screens, elevators, storage bins and bagging room.

F. J. Beharriel, 182 Van Horne St., Toronto, is manager of the company, and Richard Jones, R.R. No. 6, Orangeville, superintendent.

Elora White Lime Company. This company was organized in 1911 by Mr. John Kennedy of Guelph, who opened up a quarry and erected a hydrating plant in the township of Nichol, concession XII, near the town of Elora.

In November, 1915, a joint stock company was incorporated, owned jointly by the Toronto Plaster Company and the Alabastine Company of Paris, and work was continued under the old firm name Elora White Lime Company till July, 1916. The Alabastine Company then purchased the holdings of the Toronto Plaster Company, and it came under the management of Mr. A. J. Parkhurst, of Caledonia.

The quarry has a working face of 20 feet, and drilling is done by a Cyclone churn drill. Four kilns with forced steam draft, supply one Clyde hydrater, the lime being first pulverized in a Bonnet mill.

The officers of the company are: R. S. Haire, Paris, president; A. J. Parkhurst, Caledonia, manager; J. F. Cameron, Elora, superintendent.

Empire Limestone Company.—The operations of this company during 1916 were practically confined to loading and shipping sand. The quarry, formerly one of the largest shippers in the Province, was closed during the year. The crusher ran for one week only, crushing a few cars of road material.

The company's head office and stock yards are in Buffalo, N.Y., and all lake shipments go to Buffalo. Of the rail shipments, the records for the year 1916 show that about one-half went to Buffalo and the remainder to Canadian points; 135,000 cubic yards of sand were shipped during the year.

The officers of the company are: B. Fuller, president, Hudson and 4th Streets, Buffalo, N.Y.; John Haston, superintendent, Sherkston; and S. J. Fuller, Sherkston, assistant superintendent; 36 men were employed during 1916.

Hagersville Contracting Company.—This quarry is situated on lot 11, concession XIII, Walpole township, near the village of Hagersville. The management report that due to the scarcity of labour in 1916, the quarry was in operation for a short time only. Work was begun 26th April, and the quarry and crushing plant closed July 1st. The plant was described in previous reports of the Bureau, and remains unchanged. In normal times this quarry operates the year round, and has a capacity of 1,000 tons of crushed stone per day, with shipping facilities on three railways.

John C. Inglis is manager of the company.

Michigan Central Quarry.—This quarry, near the village of Hagersville, is operated by the Michigan Central Railway Company as a source of supply of surfacing material, stone for pier-filling and culverts, and building stone. Operations were restricted during the year, due to the scarcity of labour. A six-foot stope, 75 feet in width was taken up through the quarry, and this now gives a working face of 26 feet.

The plant includes one Ingersoll straight line compressor, capacity 425 feet, one No. 7½ and one No. 5 Austin gyratory crusher, one locomotive boiler, and two horizontal tubular boilers, 75 h.p. each; 60 men were employed under superintendent D. E. Cronin.

Milton Pressed Brick Company.—This company recently took over the plants of the Toronto Brick Company near Milton and the Medina Shale Company at Streetsville, which are now operated under the one management. Before this merger was effected, the company operated a large shale quarry and brick plant on lot 1 in the first concession of Esquesing township near the town of Milton. With all three plants in operation, the company takes a leading position in the Province in the manufacture of high grade pressed brick.

At the quarry formerly operated by the Toronto company, the bank is 75 feet high, and a six-foot stope was being taken up during the summer of 1916. The red shales of this district are easily drilled and broken, the drilling is done by hand, and the material hauled to the mixers in carts. At the No. 1 quarry, the overburden is removed by a Thew steam shovel, and the shale kept free from boulders.

J. S. McCannell is manager of the company and C. E. Hill, superintendent, employing 40 men in the three quarries.

Queenston Quarry Company.—The quarry operated by this company on lots 47 to 49, in concessions II and III, Niagara township, worked continuously throughout the year. During the summer months the crusher and screening plant are operated and crushed stone all sizes is shipped.

Charles Lowrey, St. Davids, is president and manager of the company, employing seventy-five men.

D. S. Robertson and Company.—The limestone quarry operated by this company on lot 7 in the sixth concession of the township of Nassagawaya, Halton county, is one of the oldest in the Province. For a great many years it has been a steady producer of white lime. The quarry has a working face 75 feet in height, and extends over a distance of one-half mile. At the east end of the quarry, stone for building purposes is quarried from a bed of Credit Valley sandstone which lies beneath the limestone. The plant consists of two stiff-leg derricks, two hoists with upright boilers attached, and three draft kilns with a capacity of 600 bushels of lime per day. The stone is hauled to the kilns in carts. On the date of inspection, August 30th, 1916, no drilling was being done, and one kiln was kept burning with debris and broken rock picked up near the working face.

D. S. Robertson, Milton, is owner of the quarry, and Charles McDowell, superintendent, employing 15 men.

Rocsand Company, Limited.—In several places in the Province where deposits of mixed sand and gravel are being worked, and where a large percentage of the gravel consists of boulders too large for shipment, the constituents are carefully screened and the boulder product broken in jaw or gyratory crushers. This method utilizes the whole output of the pit, and gives three products, screened sand, gravel and crushed stone.

About 20 miles northeast of Guelph on the C.P. railway in the village of Erin, Wellington county, the Rocsand Company of Hamilton work such a deposit. The excavation has a working face of 16 feet, and the material is dug by a Browning clam shell hoist, and loaded into cars with a capacity of three cubic yards each. These are hoisted to bins and discharged through a hopper feed to a grizzly, with 3-inch opening. This removes at the first operation all boulders, which are elevated to a Mitchell No. 4 jaw crusher.

The undersize is elevated to a revolving screen, which is 26 feet long by 4 feet in diameter, and built in three sections, six feet with screen opening 3/8-inch in diameter, six feet with 1 1/4-inch screen opening, and the balance with 3-inch opening. From the hoist to the working face is 150 feet, and the tracks are extended as required.

The sand and screened gravel is loaded directly into cars, and the crushed rock is stock-piled.

The officers of the company are: J. G. Baby, 106 Bay St., Hamilton, president; W. S. Connolley, Hamilton, manager; W. J. Dickson, Erin, superintendent; 10 men are employed.

Standard Crushed Stone Company.—This company with head office at Niagara Falls, Ontario, operated two quarries during the summer months of 1916. Work was continued at the St. Davids quarry on lot 44, township of Niagara. The plant at this quarry remains the same as last reported, and includes one 300-foot compressor, one No. 5 Gates crusher, and screening plant. The broken rock is loaded into cars at the working face, and hauled to a turn table. At the Ridgeway quarry, which adjoins the Coast and Lakes quarry, the pit is now 500 feet long by 125 feet wide by 25 feet deep. A 40-ton Marion shovel is used in the pit for loading broken rock into cars, and during the year, a cyclone churn drill, drilling a 4-inch hole, was used for the first time, with excellent results. Work was begun 15th May, 1916, and the plant was closed down 20th November, 1916.

Crushed limestone in sizes from 1/4-inch to 3 inches was supplied to the trade.

The officers of the company are: John Symmes, president; Robin Boyle, secretary; J. H. Barbeau, superintendent.

Work at the Ridgeway quarry is in charge of George A. McCoubrey, and 15 men were employed.

Standard White Lime Company.—This company is the largest producer of white lime in the Province, and operates quarries for the production of lime only, at Guelph, Beachville and St. Marys. The St. Marys quarry and kilns were closed during the year, also the quarry owned by the company in the city limits of Guelph. In the township of Puslinch, a short distance west of Guelph,

three kilns were in operation, with a combined output of twenty tons of lime per day. A large percentage of the lime produced at this quarry is shipped as hydrated lime.

At Beachville, near Ingersoll, the company operates a large quarry with five kilns, with a total capacity of 50 tons of white lime per day.

D. D. Christie is president of the company, and J. Kennedy, manager, with head office at Guelph.

St. Marys Portland Cement Company. The quarry and cement plant operated by this company are in the town limits of St. Marys. The stone is broken in a No. 8 Kennedy crusher, capacity 150 tons per hour, and conveyed to the plant by a belt conveyor, 400 feet in length.

The officers of the company are: Geo. H. Gooderham, president; Mark Irish, secretary and J. G. Lind, manager. Forty-five men are employed in the quarry.

Teeswater Lime Works. This company operates the oldest quarry and lime works in the neighbourhood of Teeswater, in the county of Bruce. The quarry has a working face of 30 feet, and is 133 feet wide. One draw kiln with a capacity of 90 bushels per day is operated during the summer months, and the local trade only supplied. F. A. Nicholson, Teeswater, is owner and manager of the quarry operating under the above name.

Toronto Plaster Company.—This company opened a quarry and erected three kilns and a hydrating plant late in 1916, on the south half of lot 11, concession VI, township of Culross. The plant and quarry are situated near the C.P.R. station at Teeswater, affording excellent shipping facilities.

On the date of inspection in January, 1917, the plant was not yet completed, and no work other than stripping had been done in the quarry. Three kilns with a capacity of 10 tons of lime each per day were already erected, and the plant was expected to be completed by April 1st, 1917.

In the process used here, about 15 per cent. of water by weight is added to the lime, and the finished product contains about 17 per cent. water, the remainder being taken up in hydration.

The head office of the company is 1062 King St. West, Toronto, and the officers are: John Kennedy, Guelph, president; H. W. Calkins, Toronto, vice-president; T. G. Kennedy, Teeswater, manager.

Wentworth Quarry Company.—This quarry is situated near Vinemount station, T. H. & B. railway, on lot 1, concession V, township of Saltfleet.

The output of the quarry is confined to crushed stone, all sizes; no dimension stone or rubble is shipped. The plant is well located to supply the trade west of Hamilton, and the output is increased each year.

The crushing plant includes one No. 7½ McCully crusher, one No. 5 McCully crusher and one six-section revolving screen. The plant is driven by a Ruddbridge twin-cylinder gas engine, supplied by a 115 h.p. gas producer plant.

F. W. Schwendiman is manager, employing 25 men.

Gypsum

Ontario Gypsum Company Limited.—This company was formed in the fall of 1916, by an amalgamation of the Crown Gypsum Company of Lythmore and the Alabastine Company of Paris and Caledonia. Included in the merger are the mine in the township of Oneida, and the grinding plant at Lythmore formerly operated by the Crown Gypsum Company, the mine and grinding plant at Caledonia formerly operated by the Alabastine Company of Paris, and the Carson mine in Oneida township. Up to the close of 1916, the operations were carried on by the former owners as described in previous reports, and on January 1st, 1917, the new company took over the management.

The Paris interests of the Alabastine Company are not included in the merger.

The Carson mine was operated with a small force for three months during 1916. The mill and mine previously operated by the Crown company were closed by the new company, and will not be operated for some time. By this deal, the Ontario Gypsum Company acquires possession of about 1,000 acres of proven ground in the gypsum belt in addition to two large grinding plants.

The officers of the Ontario company are: W. G. Case, Buffalo, president; R. E. Haire, Paris, secretary-treasurer; and A. J. Parkhurst, superintendent.

VI.—BLAST FURNACES AND REFINERIES

Blast Furnaces

Algoma Steel Corporation.—The three furnaces of the above company situated at Steelton, Ont., were operated to capacity during 1916. The output ranged from 950 to 1,050 tons daily of pig iron. The Magpie and Helen mines of the company supplied about 30 per cent. of the ores used and the remainder was imported from the United States. James H. Bell is superintendent; 300 men were employed. A 100-ton Greenawaldt sintering plant was put in operation by the above company, in July, 1916. Flue dust from the blast furnaces was treated here during the balance of the year. Later on it is planned to treat residue from the acid plant and tailings from the Helen mine concentrator. The installation consists of two 7 ft. by 12 ft. roasting pans with mixing bins, loaders, burners, draft fans, etc. J. Frater Taylor is superintendent; 16 men were employed.

Canadian Furnace Company.—The blast furnace of this company, Port Colborne, which has been fully described in previous reports, ran to capacity during 1916, with the exception of a shut-down from April 1st to May 16th, while the furnace was being re-lined.

During the year a new machine shop was erected, and new blowing engine unit installed. Many changes and repairs were made with a view to rendering working conditions as safe as possible.

B. Marron, Buffalo, is president of the company; F. E. Deschenes, superintendent; and D. J. Higgins, mechanical superintendent; 135 men were employed at this plant during the year.

Standard Blast Furnace.—The blast furnace at Deseronto, owned by the Standard Iron Company, was operated continuously throughout 1916. The Parry

Sound furnace remained closed. Charcoal pig is produced at Deseronto, chiefly from Mesabi range ores, although some experiments have been carried on with a view to using Ontario magnetites. The company shared in the increased business due to war orders.

The officers of the company are: R. J. Mercur, president; S. F. Belknap, managing director; O. O. Landig, works superintendent; 70 men were employed during the year.

Steel Company of Canada. The two large furnaces operated by this company at Hamilton were in blast continually during 1916, with the exception of short periods, when shut-downs had to be made for re-lining and repairs.

The whole force of the company was directed towards increased output for munition purposes.

The safety rules mentioned in last annual report were approved by the Compensation Board, and an Inspector appointed by the Metal Trades Safety Association. Results of this step are shown in the decreased accidents around the furnaces during the year.

Robert Hobson is president of the company; R. G. Wells, general superintendent, and Charles Grimes, superintendent of blast furnace.

Refineries

Coniagas Reduction Company. The silver smelter and refinery operated by this company near Thorold worked to capacity throughout the year. Most of the ore treated came from the Coniagas mine owned by the company, but custom ores and mill products are also purchased.

The officers are: R. W. Leonard, president and general manager; R. L. Peek, superintendent; J. J. Mackan, secretary; 150 men are employed.

Deloro Smelting and Refining Company, Limited.—The plant and sampling and refining methods employed by this company at its silver refinery situated at Deloro, Hastings county, were fully described in the 25th annual report of the Bureau. The output of stellite was considerably increased in 1916. This new cutting metal, composed of cobalt, chromium and tungsten without any iron, has had much success, and for many operations has proved superior to high speed steel. Cobalt and nickel metals are now supplied to the trade in the form of grain, cube, shot and ingot. A plant was installed during the year for powdering aluminum metal in the form of dust. A considerable quantity of this material is used at Deloro as a precipitant.

Other changes during 1916 included the installation of a complete sprinkler system with tanks over all buildings. Twelve well designed houses for workmen were also built near the works.

The officers of the company are: M. J. O'Brien, president; Thomas Southworth, vice-president; S. B. Wright, general manager; S. F. Kirkpatrick, consulting metallurgist, and F. A. Bapty, secretary-treasurer. Two hundred men were employed during the year.

Electro-Zinc Company, Limited.—The plant erected by this company at Welland, for the production of electrolytic zinc spelter, operated most of the year.

Concentrates from the mine at Notre Dame des Anges, Portneuf county, Quebec, were treated.

The plant was designed by E. Watts, who invented the process of refining. On the date of inspection, 11th July, 1916, 50 electrolytic cells were in operation, and it was the intention to increase the cell capacity.

In the plant are one Abbe ball mill, one vacuum pump, one tilting furnace, one filter tank, four storage tanks, two agitator tanks and one sump tank.

The officers of the company are: Weston Lewis, president; L. D. Adams, vice-president; J. P. Wells, secretary; J. H. Maxey, treasurer. The secretary's office is at Sherbrooke, Quebec, and the treasurer's office at Gardiner, Maine, U.S.A.

Kingston Smelting Company, Limited.—This company was organized in October, 1916, and took over the lead mine at Perth Road and smelter at Kingston from the trustees of the North American Smelting Company, on a five year lease with option to purchase.

The mine was sub-leased to the Indian Lake Mining Company, but no work was done during the year. The smelter at Kingston has been repaired and extensive alterations made, particularly in the bag house and power departments. Several cars of lead concentrates from Missouri and British Columbia have been smelted. It is the intention of the company to assist wherever possible in the production of domestic ores in order to secure a steady supply for their furnaces.

The smelting plant consists of two Root blowers, two Scotch hearths, one blast furnace, one refining settler, reverberatory furnaces and bag house.

The officers of the company are: Hugh Sutherland, Winnipeg, president; E. M. Cromwell, New York, vice-president; G. W. R. Fallon, New York, secretary-treasurer; A. McKinnon, Kingston, general manager; 10 men were employed in February, 1917.

Metals Chemical, Limited.—The plant operated by this company at Welland worked to capacity throughout the year. The method of treatment was fully described in the 25th annual report of the Bureau. Low-grade cobalt ores and residues are purchased, and a variety of the chemical compounds of cobalt and nickel manufactured. There is also a considerable output of metallic cobalt, and nickel.

C. G. Richardson, Welland, is president of the company and J. H. Charles, secretary. Sixty men are employed.

Tivani Steel Company.—The process in use at this plant in Belleville was fully described in the 23rd annual report of the Bureau. The plant was idle for some time; in 1916, some additions were made and the manufacture of tool steel in the electric furnace resumed. A high-grade steel is produced directly from the titaniferous iron ores from the Orton mine in Hastings county. This work was suspended in the fall of 1916, and the furnaces used for manufacturing ferro-molybdenum for munition purposes. With a suitable concentrate a high-grade product is obtained, and it is probable that the plant will be enlarged in 1917 and more furnaces added to meet the heavy demand for the ferro compounds of tungsten and molybdenum.

J. Walter Evans is president of the company and J. M. Wallace, secretary.

LONG LAKE GOLD MINE, SUDBURY DISTRICT

By

M. B. BAKER

Introduction

The writer was deputed by the Bureau of Mines of Ontario to investigate, during the summer of 1916, certain mineral deposits in northern Ontario. He was instructed to make a detailed examination of the Long Lake gold mine, southwest of Sudbury, and to map the immediate vicinity geologically. He was then to proceed to the northern part of the Timiskaming mining division, and examine the Alexo nickel mine, and then investigate the economic possibilities of other serpentine areas for nickel, chromium, asbestos, etc. The serious forest fires, which raged over this northern area during the summer, interfered with his work, but it is hoped that the information set forth in the following report will be of importance to prospectors in this district.

The writer was assisted by A. W. Wheatley, a student of the University of Toronto, and wishes to thank Mr. Wheatley for faithful and valuable aid throughout the field season. He desires to acknowledge the kindness of the Canadian Exploration Company and its manager, R. W. Brigstocke, for access to all information at Long Lake mine, and for accommodation granted to himself and assistant while working in this area. He also wishes to thank Major Pullen and Mr. Anderson for similar kindness shown at the Alexo Nickel mine, and Dan O'Connor for information and aid in examining serpentine areas which he was investigating.

Long Lake Gold Mine

The Sudbury district has long been known as Canada's richest producer of metalliferous ores. These are chiefly ores of nickel and copper with a few rare associated metals like platinum and palladium, so that the discovery of a gold deposit of economic value was interesting. It was purchased by the Canadian Exploration Company and developed under the management of R. W. Brigstocke, who mined approximately 200,000 tons of ore averaging about eight dollars per ton in gold.

Long Lake settlement is six miles due south of Sudbury, and marks the northeast end of a lake nine miles in length and in few places more than half a mile in width. This lake lies in the northeast and southwest depression conforming to the rock structure of the country. The mine is located near the southwest end of the lake, and is best reached by a wagon road from Naughton, the first station west of Copper Cliff on the Canadian Pacific railway. A drive of ten miles through the Whitefish Lake Indian Reserve brings one to the mine, which is situated on a group of hills overlooking the lake and much of the surrounding country.

South of the Canadian Pacific railway there has been little detailed mapping done. In his map of the Sudbury nickel region to accompany a report on that

nearby. Dr. Coleman maps the area as far south as Timber Berth No. 69. The geology of this area has never been worked out, and as Long Lake gold mine lies within it, the early part of the field season was spent on this work by the writer. The accompanying sketch map in black and white shows the general geological features.

The rocks are entirely pre-Cambrian in age, and show the rounded and peneplaned topography characteristic of pre-Cambrian areas in Canada. The outstanding feature of this group is the northeast and southwest structural relationships. It is most significant that the pre-Cambrian almost everywhere in Canada shows this character. The strike of the formations, the elongated axes of intrusives, the crests of the ridges, the drainage basins, the lakes and marshes all testify to the northeast and southwest structural features so regularly met with in all parts of Canada occupied by these rocks.

Age Relationships of Rocks

The age relationships of the rocks present in this area are in descending order as follows:—

POST LAURENTIAN.....

KEWEENAWAN:—Trap Dikes and Diabases.
Eruptive contact.
ALGOMAN:—Granites with Pegmatite Dikes.
Eruptive contact.
PRE-ALGOMAN:—Diorites with Gabbroic Facies.
Eruptive contact.
TIMISKAMING SERIES:—Quartzite, Arkose, Greywacké, and Conglomerate.

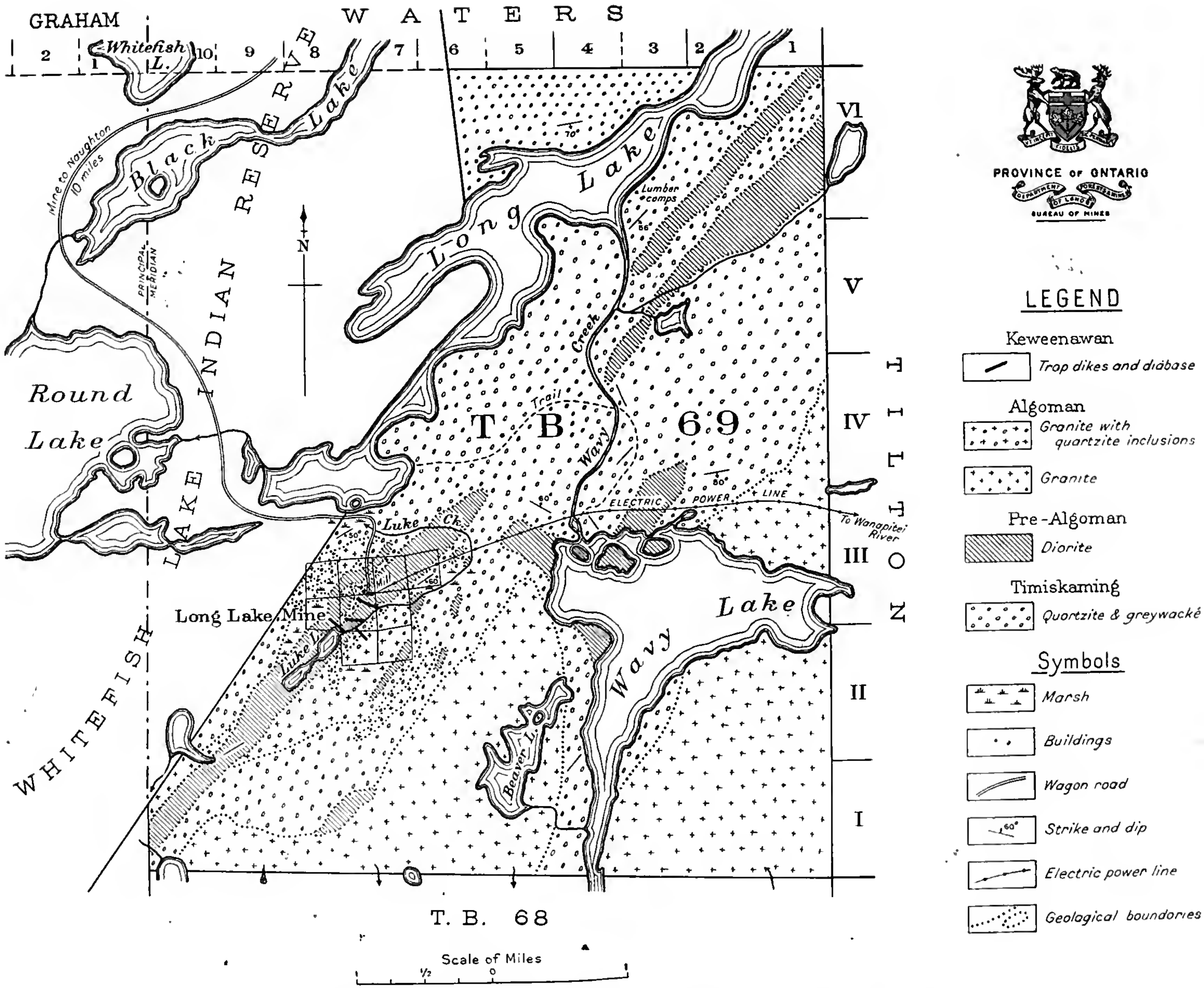
Timiskaming Series

The oldest group in this district is a series of metamorphosed sediments represented for the most part by quartzites, but with considerable amounts of arkose and greywacké, and subordinate amounts of conglomerate. All have a predominantly northeast and southwest strike, and very steep dips, mostly towards the southeast. There are many local deviations from this in the vicinity of later intrusions, but on the whole this is the prevailing structure, and is well brought out in the maps which accompany this report. The rocks have a pronounced pinkish shade and contain considerable feldspar, so that they are readily taken for granites or other acidic igneous rocks. Their bedding is quite prominent in places, and their perfect interlayering with greywacké and conglomerates precludes any but a sedimentary origin for them.

The greywacké is of variable character, but consists of prominent layers of quartz or gritty fragments, in a somewhat softer ground-mass of dark grayish-green grains, causing differential weathering, so that a ribbed or corrugated surface is produced parallel to the bedding. In some places the beds are slaty in character, and these dark bands serve well in tracing out the structures of the group as a whole.

The most prominent member of this group is the quartzite, which occurs in thick beds with distinctly sedimentary structures, even to crossbedding in places. Even the cleanest of the quartzite shows the presence of some feldspar grains.

[1]The Nickel Industry, Bull. No. 170, Dept. of Mines, Ottawa, 1912.



PLAN SHOWING GENERAL GEOLOGY IN VICINITY OF LONG LAKE GOLD MINE, SUDBURY DISTRICT.

when examined under the microscope. The feldspars are partly microcline, and partly albite or oligoclase.

Very little conglomerate is to be found in this district, but a few bands do occur. A striking occurrence is at the mouth of Wavy creek on the east shore, where there is a band of conglomerate with boulders six inches or more in diameter. This band strikes northeast with the general strike of the country, and dips at 56° to the southeast. Many of the boulders are granite, much altered, and show gneissic textures. They are no doubt remnants of Laurentian granite, and serve with other evidence to confirm the belief that the Sudbury series and the Timiskaming series are one and the same. Narrow bands of conglomerate may also be seen in front of the stable at Long Lake mine.

Pre-Algoman

Later than the sedimentary rocks just described, but earlier than the Algoman granite, is a series of diorites, which cut the Timiskaming series and enclose many fragments of it. Many of these included masses of quartzite and arkose are so much indurated and silicified by this intrusion as to have become dense and hard, even jasperoidal in character. Under the microscope these diorites are seen to be made up of common green hornblende and long lath-like crystals of plagioclase. In some places the latter appear almost like phenocrysts, giving the rock somewhat the aspect of a porphyry; but it is strictly an intrusive plutonic rock, and is a diorite.

These masses have an elongated shape controlled by the bedding of the Timiskaming series; their distribution and shape are shown on the accompanying map. The diorite is clearly later in age than the Timiskaming series, since it penetrates it, and holds large and small masses of these sediments as inclusions in itself. The ore body is confined to one of these large blocks of arkose, entirely surrounded by diorite. The relationship is best shown on the large scale map (No. 26e) of the mining claims, which accompanies this report, and which shows the detailed geology.

That the diorite is pre-Algoman, or at least early Algoman, in age, is clear, since fresh pink granite cuts the diorite in places, and in others, contains digested masses of it, which are very like pink syenites, and might easily be mistaken for the latter rock. The enlarged map shows in an interesting manner how large masses of the Timiskaming series were torn off and carried away from their natural position, as for example on claims S. 1100 and W.D. 601 and 602.

Algoman

Recent work on the pre-Cambrian rocks of Canada has shown that almost everywhere there is a second series of intrusive granites of widespread dimensions, formerly confused with the Laurentian. It is pointed out above that the Timiskaming conglomerates contain boulders of pink granite and granite gneiss, which must be of earlier age. On the other hand, the Timiskaming series is cut by another intrusive of pink granite, often gneissoid, clearly of later age, and to this later series the name Algoman has been given, and is being generally accepted.

In the Long Lake area the Algoman granites cut both the Timiskaming sediments, and the diorites just described, and contain fragments of both in many places. This feature is indicated on the maps with this report, but the smaller inclusions are not to scale, nor do they purport to be accurately placed. The intention of the writer is to indicate a mixed area south of the mine. An interesting feature is shown on the large scale map (No. 26e) of mining claims W.D. 601 and 602, where the Timiskaming sediments formerly continuous to the northeast have been broken up and displaced. The belt at the southeast corner of W.D. 602 is bent to the east through an angle of 35°, while the mass in the northwest corner of W.D. 601 has been forced out of the strike of the former belt.

The introduction of the Algoman was accompanied by much silicification of the surrounding rocks, hence fractures formed in the Timiskaming series, in the diorites, and even in the Algoman granite itself, are healed up with quartz. This is strikingly shown at the angle of bending in the southeast corner of W.D. 602, where the much fractured quartzite is impregnated with quartz veinlets, which completely closed up the fractures.

The Algoman granite is a coarse grained rock composed of pink orthoclase and microcline, with bluish to milky colored quartz. Biotite is often present, and sometimes hornblende. The rocks are noticeably red, coarse grained, and fresh in appearance. Along the margins of masses there is sometimes a well developed gneissoid structure, which appears to be due to the alignment of constituents along the contact, as a sort of false flow structure, rather than to dynamical forces. This gneissic structure, in the absence of other evidence, often causes Algoman rocks to be mistaken for Laurentian gneisses.

Keweenawan

Later still than the Algoman granites, and cutting them, as well as all earlier rocks, is a group of diabase dikes, which usually cut across the general northeast and southwest structure of the country. These dikes vary in width from a few inches up to thirty-five feet. In other parts of Ontario a thick series of sediments which overlies the Algoman rocks unconformably, is cut by similar dikes, and its age is therefore known. In this area, however, no such sedimentary rocks occur. It can only be said, therefore, that these dikes are post-Algoman in age, but their perfect similarity in composition and texture seems to justify their correlation with the proven Keweenawan of other areas. Miscroscopic examination shows them to be mostly augite diabase, with lath-like crystals of basic feldspar, penetrating and often surrounded by the augite. Their texture is therefore the same as that in the proven areas of Keweenawan in other parts of Ontario. They are remarkably fresh and undecomposed and are the youngest of the pre-Cambrian rocks of this area.

Ore Deposition

In the description of the pre-Algoman diorite given above, it is mentioned that large blocks and masses of the Timiskaming series are included in the diorite, and that the Long Lake mine is located in one of these blocks. The ore body is unique, as there is no vein or ore-filled space of any dimensions, but merely a core or chimney of Timiskaming quartzite impregnated with arsenopyrite and

iron pyrite, and minor amounts of pyrrhotite, galena, and copper pyrites. The gold is associated chiefly with the arsenopyrite, but the iron pyrites also carries smaller percentages of it.

There is a noticeable increase in gold values with increase of feldspar in portions of the quartzite. This leads to the miners' terms "red ore," "blue ore," "brown ore," etc. The red tones are due to predominance of feldspar, the blue to finely disseminated arsenopyrite in the quartz, the brown ore to the dust like arsenopyrite in the feldspar. The brown ore is consequently the richest. The arsenopyrite is rarely in crystals visible to the naked eye, whereas the pyrite occurs in two forms. There is one generation of pyrite in easily recognizable crystals, while a second generation is in fine dust-like particles similar in dimensions to the arsenopyrite. The gold is associated with the fine grained arsenopyrite and pyrite, and not with the coarser variety.

In the discussion on the Algoman intrusives, it is stated above that the end phase of the action was accompanied by much silification, and that mineralizers affected the contacts considerably. Amongst all this mineralization, however, of which there are abundant examples throughout the area, there is no case that has proven gold-bearing. Small quartz veins even cut the ore body itself, but show no mineralization. While the Algoman intrusive produced much silicification, it did not produce the gold-bearing sulphides. These were of earlier age.

The probable source of the ore was the diorite which surrounds the masses of quartzite. Hydrothermal solutions would introduce the silica, the sulphides, the gold itself, and would deposit these in the pore spaces of the arkose mass, showing a preference for the parts richer in feldspar. It is significant, however, that other masses of Timiskaming sediments, similarly enclosed in diorite, do not show similar effects, but this may be due to their being quartzite, rather than feldspar-holding arkose. The writer would mention finding a large boulder of quartzite east of Wavy lake, which was well impregnated with sulphides, but assayed only eighty cents per ton in gold. As this mass could not have come from Long Lake mine, there must be other occurrences of possibly economic value.

While the diorite is pre-Algoman in the sense that it is cut by the Algoman granite, it is doubtful whether it is much older than the latter rock. It may mark merely the opening phases of the Algoman activity, and be therefore almost contemporaneous with the granite intrusions. Small quartz stringers which cut the quartzite, and others which cut the diorite, even adjoining the ore body, while showing coarse grained pyrites, do not carry gold, so it seems clear that the ore deposition accompanied the earlier diorite activity, and not the later granite intrusions. The gold is so closely associated with the sulphides that free milling proved a failure, and cyanidation is used throughout the process, actually being introduced in the stamp-batteries, and carried throughout the ball mills, agitators, etc., to the filter presses. By this means the manager has succeeded in getting a very complete extraction of gold from this refractory ore.

Faulting

Post-Keweenawan faulting of a most interesting and important character has taken place in the immediate vicinity of the mine. At least two fault planes

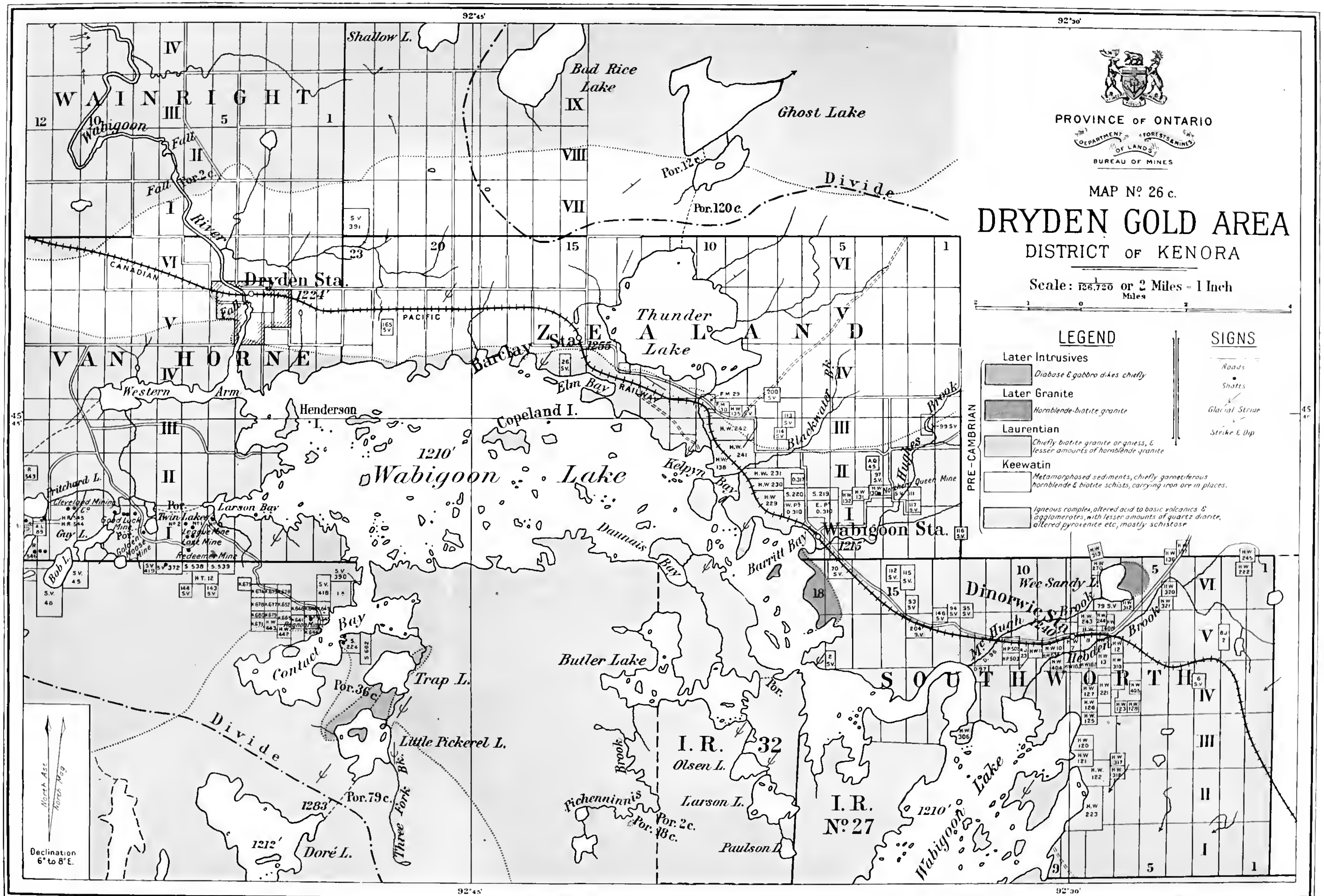
are well shown on the large scale map of the mining claims. One fault begins in Luke lake, and strikes northeastward across claims W.D. 602 and S. 1100. This fault is marked by a pronounced ravine, with prominent fault scarp on the southeast side especially. This fault at the ore body on W.D. 602 dips at 45° to the east at the surface, and starts in diorite, but about forty feet down it meets the quartzite, and there straightens up to about 70°, and follows the contact downward to and beyond the bottom of the quartzite mass. This being the case, the presence of the fault has no effect on the continuation of the ore body, as the contact would cut off the ore quite independently of the fault. This was the opinion expressed by the writer at the time of his visit, and extensive subsequent diamond drilling appears to have confirmed it.

It will be noticed by referring to the detailed structural map (No. 26 E.) that a large diabase dike "A" on claim S. 1128 strikes southeast and meets the fault on its western side. The continuation of this dike is on claim W.D. 602 showing a heave, along the fault, of 110 feet. Similarly dikes "B" and "C" on claim W.D. 602 have no continuation to the northwest across the fault. A careful search for these lost ends fails to show them, although a very small portion of a diabase dike does occur in the hanging wall across from "C" and with a similar displacement of 110 feet. Its strike is, however, northeast and southwest, and the writer is not sure that it is the same as dike "C." No continuation of dike "B" could be seen to the west, but a heavy overburden of soil at this point could very well have hidden it.

Prominent striations and gouges on the fault walls at the second and third level in the mine, show that relatively to the hanging or east wall, the opposite wall moved downward and southward at an angle of about 70° to the horizontal. A few remnants of "drag ore" on the fault plane at the second and third level add strong evidence to the support of this view. The writer would repeat, however, that this does not mean a continuation of the ore body below the fault plane, but that the ore bodies continued down to the contact of the quartzite with the diorite, and when the faulting occurred along this contact, it simply dragged or left behind remnants of ore along the fault plane.

A second fault starts also in Luke lake, and strikes eastward along the course of Luke creek, leaving a high escarpment on the south side of the fault. Following dike "A," the writer found it continued on the southeast side of this fault, and showing on claim W.D. 601 with a heave of 125 feet. The dike marked "B" is similarly displaced, and continued southeast of the fault as shown on the map. The continuation of dike "C" could not be located across the fault. This detail shows that relatively to the main mass south of the second fault, the area marked W.D. 602 moved southwestward, and that relatively to this mass, the hanging wall side of the first fault moved still farther southwestward. Other minor faulting occurs in the vicinity, but these two faults are the most important.

To accompany Report by E. Thomson, in Vol. 26, Part I, of the Ontario Bureau of Mines, 1917.



W. J. Bell, Cartographer

Topography and Geology from Manitou Lake sheet, Con. Geol. Survey, 1902, revised by E. Thomson, 1916.

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DRYDEN GOLD AREA

By

ELLIS THOMSON

Introduction

Acting on instructions received from T. W. Gibson, Deputy Minister of Mines, the writer spent the months of June, July, and August, 1916, in the vicinity of Wabigoon lake, Kenora district, in geological field work. From the data collected at that time a map has been made showing the various geological formations. Special attention had been directed to this region by a recent discovery of gold ore at Contact bay, a large bay in the southwest corner of Wabigoon lake. On this account a considerable portion of the time was spent in the immediate neighbourhood. The writer was particularly fortunate in having as his assistant, H. V. Ellsworth, whose services proved invaluable throughout the summer. He is also indebted to Dr. Ellsworth since that time for many helpful suggestions in the compiling of this report. During the months of July and August, Charles W. Merrill, of Wabigoon, rendered efficient service as canoeman and cook, while for a special trip to Gull lake in the month of August, C. D. Coates, of Dryden, proved a satisfactory guide.

This area is included in the general geological map by Wm. McInnes[1], but apart from the report by A. L. Parsons in the 20th Report of the Bureau of Mines,[2] no detailed work has been done in the field. A small part of the northern portion is also shown in map No. 1061 by W. H. Collins[3]. The stretch of country examined includes the townships of Wainright, Van Horne, Zealand, and Southworth, as well as a considerable section of the unsurveyed territory south of Lake Wabigoon.

Topography

The topography of the area is characterized by smooth and undulating surfaces, Fig. 1, particularly in the northern section, but occasionally bold and rugged hills protrude above the general contours, as in the vicinity of Trap lake. The northern half, including the townships of Wainright and Zealand and the northern half of Van Horne, is covered with a heavy overburden of white clay, on which are many prosperous farms, and few rock outcrops are to be seen. This northern section has been largely cleared, only the eastern part of Zealand township being still wooded. On the other hand, the southern portion of the field is covered with a fairly dense growth of poplar and birch, with an occasional evergreen, and here rock outcrops are fairly numerous. The whole tract, however, carries a considerable overburden of stratified clay, well illustrated on the shores of Wabigoon lake, Fig. 2. This lake is characterized by a low-lying shore-line with banks of white clay, which material comes down to water-level or within a few feet of it.

[1] Map No. 720, District of Rainy River, Manitou Lake Sheet, Can. Geol. Sur., 1902.

[2] Gold-fields of the Lake of the Woods, Manitou, and Dryden, Ont., Bur. Mines, 1911.

[3] Map accompanying Geological Reconnaissance of National Transcontinental Railway between Lake Nipigon and Clay lake, Ont., Can. Geol. Sur., 1909.

These clay banks being easily cut away by the action of the waves, the outline of the lake changes considerably even in the course of a year, and many small islands disappear, while new ones are formed by cutting off the ends of peninsulas and points. In Fig. 3 is shown one small island which has very nearly been cut

Fig. 1.—View of Larson bay, Wabigoon lake, showing flat topography.

Fig. 2.—Stratified clay, Anderson island, Wabigoon lake.

in two in this way. Erosion is hastened by the fact that the level of the lake has been raised at different times by the Dryden Timber and Power Company to facilitate logging operations.

Geology

The rocks are for the most part Keewatin in age, but a considerable area of Laurentian rocks occurs to the north, as well as a smaller one in the southwest corner in the vicinity of Contact bay. There are also a few small outcrops of later granite, gabbro, and diabase scattered throughout the field.

The classification is as follows:

1. Pleistocene deposits: stratified clay, glacial and recent.
2. Later diabase and gabbro dikes, probably Keweenawan in age.
3. Later granite:—hornblende-biotite granite, probably Algoman.
4. Laurentian: biotite granite or gneiss for the most part, also a little hornblende granite.
5. Keewatin:—(a) Igneous complex volcanics acid to basic, agglomerates, pyroxenite, etc.
   (b) Metamorphosed sediments iron formation, garnetiferous hornblende and biotite schists carrying magnetite and pyrrhotite in places.

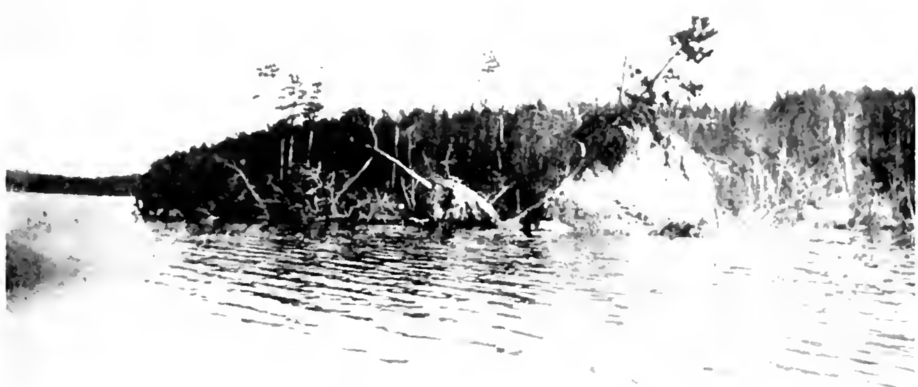


Fig. 3.—Weathered island, Contact bay.

Pleistocene Deposits

As has already been mentioned, the rocks are covered in a great many places by deposits of stratified clay. Occasionally a layer of sand or gravel appears, but the great bulk of the Pleistocene deposits is made up of a white clay, well stratified. This material is best shown along the shores of Lake Wabigoon, where it sometimes attains a thickness of fifteen or twenty feet. It has been found eminently suitable for the cultivation of clover. This crop is threshed for the seed, which is reputed to be the finest on the continent, and commands the highest prices. Immediately below the clay deposits, more particularly on the shores of the lakes, a great many flat rock outcrops have been recently uncovered. Wherever this is the case, glacial markings are very numerous, the direction being S 28° W magnetic, with occasional local variations to southwest or south. These glacial striæ were encountered chiefly on Wabigoon, Little Wabigoon, Trap, and Butler lakes, but in one or two cases they were observed inland, notably in the vicinity of the Good Luck property in the southern part of Van Horne, where deep grooves appear in the agglomerate rock.

Keewatin Igneous Complex

This series, which forms the great bulk of the rock in the area, is made up chiefly of volcanic varieties, but there are some small areas of coarse-grained plutonic rocks. The volcanics range in composition from a rhyolite or quartz porphyry, to an altered diabase or basalt, and the corresponding schists. That these rocks are surface flows is abundantly illustrated by the great number of porphyritic, amygdaloidal, vesicular, ellipsoidal, and ophitic structures encountered in them in all parts of the field, not to mention the occasional occurrence of small tufaceous areas. The more acid rocks have a marked tendency to be porphyritic, while the more basic ones are generally either amygdaloidal or ophitic

Fig. 4.—Keewatin basic and acid flows, lot 6, concession 1, Van Horne township.

in structure. Nearly all these rocks, and in particular the basic ones, have developed a more or less pronounced schistosity, the general direction of the strike being east and west and the dip, for the most part, vertical. In places the altered diabases pass gradually into quartz diorites or altered pyroxenites, but these seem to be local plutonic phases only, and never occur in large areas. Accompanying these volcanics are numerous areas of volcanic breccias or agglomerates, varying in dimension from a few square feet to a square mile or so. These fragmentals are made up of angular fragments of the neighboring rocks, generally rather basic in composition, cemented together by a somewhat more acid material. A great

many of the rocks of this series have been so much altered and metamorphosed that their original character is entirely lost, and in this rather nondescript class are found such rocks as felsite, felsite schist, sericite schist, biotite schist, talc schist, and calc schist. As these rocks have only a local importance, and are surrounded by rocks of undoubted volcanic origin, it seems quite safe to assume that they are part of the same series. This formation has been sub-divided by both Wm. McInnes and A. L. Parsons in their maps of this country. However, as there is such a bewildering confusion of acid, basic, and fragmental rocks in this series, it has been considered inadvisable by the writer to attempt at present further sub-division. The extreme complexity of the acid and basic flows is well illustrated in the country immediately west of Larson bay in the southern part of Van Horne township. Here bands of acid and basic volcanics alternate in a few yards. In this particular locality as the contacts between the acid and basic flows, Fig. 4, are well marked, it would appear that the flows were not quite contemporaneous. In all other parts of the field, the acid rocks merge into the basic ones so gradually, that they would both seem to be part of the same effusion. This formation carries numerous veins, which for the most part follow the strike of the rocks, but occasionally cut across it. The gangue of these veins is usually white quartz, but occasionally includes ankerite, chlorite, and tourmaline. In conclusion, it may be stated that the three prominent rock types of this series are the quartz porphyries or dacites, the altered diabases and basalts and their corresponding schists, and the agglomerates.

Keewatin Igneous Rocks in Van Horne Township

These rocks take up about 75 per cent. of the area of this township, extending from the southern boundary to within a mile and a half or two miles of the northern boundary. Along the contact between this series and the metamorphosed Keewatin sediments in the northern part of the township, this formation seems to be represented almost invariably by a quartz porphyry or dacite, an exception being at the good contact on the east bank of the Wabigoon river, where the schists of the sedimentary series are in contact with an altered diabase schist. South from this contact the rock becomes more basic, particularly along the north shore of Wabigoon lake, and is represented for the most part by an altered diabase schist or diabase. This basic phase extends through concession IV, with, of course, small areas of the more acid rock included. Concessions II and III contain numerous areas of agglomerate mixed with both the acid and the basic rock types. This agglomerate is particularly well developed in the vicinity of Twin lakes, where it occurs in areas of several hundred square yards. It is also well shown in lot 1, concession III, along the shore of Wabigoon lake. The breccia, however, does not extend in a broad band across the country, as shown on previous maps, but is broken up into a great number of areas, most of them small, and is mixed up with the other rocks, both acid and basic. Concession I is taken up chiefly with alternating bands of acid and basic flows, the former predominating slightly, particularly towards the southern boundary of the township, with occasional small areas of agglomerate. These brecciated areas are more numerous in the western part of the concession in the neighborhood of Pritchard and Flambeau lakes, and also along the southern shore of Larson bay of Wabigoon lake, Fig. 5.

The rocks outcropping along the southern boundary of this township are for the most part acid, varying from a quartz porphyry to a felsite or felsite schist. The latter two are very fine-grained, and consist chiefly of quartz, orthoclase,

Fig. 5.—Keewatin agglomerate south shore of Larson bay

Fig. 6.—Banded Keewatin igneous rocks, Anderson island.

plagioclase, and sericite or chlorite. On Anderson island an altered diabase schist alternates with a more acid rock, Fig. 6, both being cut by numerous small veins of tourmalinized quartz. This peculiar vein-material resembles charcoal, having

the same fibrous appearance and with transverse fracture similar to cracks in charcoal. Associated with these two rocks on this island is a small area of altered pyroxenite, consisting chiefly of pale-coloured hornblende and a grey indefinite product. The same tourmalinized quartz was also encountered in another part of the township in lot 10, concession III, near the road from Dryden to the Redeemer mine. Amygdaloidal rocks are fairly plentiful in the southwestern corner of the township, and some vesicular structures were also found in this portion.

Keewatin Igneous Rocks in Zealand Township

This series in the western part of the township up to the western shore of Thunder lake, is confined entirely to a narrow fringe along the north shore of Wabigoon lake. The formation is represented in this western part chiefly by a quartz porphyry or dacite. Where, however, the fringe is wider, an altered diabase or diabase schist outcrops along the shore of Wabigoon lake. These rocks are for the most part quite schistose, striking east and west, and have a vertical dip. From here on to the eastern boundary of the township, the formation gradually broadens out, till at the eastern limit it extends from the middle of concession III to the southern boundary of the township. In the eastern section of the township it is represented for the most part by an altered diabase or basalt and corresponding schists. At the contact with the sedimentary series, it is almost invariably represented again by a quartz porphyry or dacite. This acid porphyritic rock is especially prominent at the point where the road between Dryden and Wabigoon crosses Thunder creek, which is the only place in this section where there is anything like a visible contact between this series and the sediments. Here the acid rock outcrops immediately below the bridge, while the sediments appear about 100 to 200 feet up the stream. This acid rock shows in thin section fairly large phenocrysts of quartz, as well as a few of both orthoclase and plagioclase in a fine-grained matrix consisting chiefly of quartz, biotite, and muscovite, with lesser quantities of epidote, magnetite, and apatite. In this rock most of the feldspar has apparently been leached from the ground-mass, but the porphyritic nature of it precludes the classing of it with the sediments. In a cutting on the Canadian Pacific railway track west of Wabigoon station, between mile posts 50 and 51, a peculiar pyritic graphite schist occurs along with the other rocks of this series. This is a very schistose rock, striking east and west, and with a vertical dip. It resembles an ancient slate, having very good slaty cleavage, and showing in thin section graphitic material, quartz, and pyrite. A good example of pillow lava occurs in this township just north of the town of Wabigoon, near the road between lots 6 and 7 in concession I. The rock is an altered diabase, and the pillows are very well marked, Fig. 7.

Keewatin Igneous Rocks in Southworth Township

This formation covers the whole of this township, and is for the most part basic in character, particularly to the north. The rocks along the small extent of the shore-line of Lake Wabigoon included in this township, are predominantly basic in character, being chiefly altered diabases or basalts and their corresponding

schists. In this stretch there is one mining claim, S.V. 2, concession V, lot 5, where a graphitic schist outcrops, carrying considerable pyrite. This rock, which is crumpled and contorted in places, is similar to that in the township of Zealand on the C.P.R. track west of Wabigoon. It covers in this case, however, a very small area, outcropping only for a few yards back from the present water level. About 50 feet from the shore the altered diabase or basalt rock outcrops. To the north the same basic phase of the series outcrops at infrequent intervals along the C.P.R. track. At points along the right-of-way, between Wabigoon and Dinorwic, the basic phase shows local variations to a coarser plutonic rock, grading into a quartz diorite. This coarse type is to be found outcropping a few yards east of Wabigoon station and again between mile posts 18 and 19 still further east. At the latter locality this rock in thin section shows a rather coarse aggrega-

Fig. 7.—Pillow lava, lot 6, concession I, Zealand township.

tion of hornblende, quartz, and plagioclase, with lesser quantities of ilmenite and its alteration product, leucoxene. The plagioclases have been so much altered to kaolin that their exact character is difficult to determine accurately, but their extinction-angles correspond best to those of andesine. This coarse rock merges in a few yards into the usual fine-grained basic variety. The rocks in that portion of the township on the south side of the narrows between Wabigoon and Little Wabigoon lakes are much more acid in character, while those along the north and east shores of Little Wabigoon lake as far as the southern boundary of the township, show alternations of the acid and basic rocks in about equal proportions. The acid rocks are especially prominent on the long peninsula opposite concession II. At this point a very schistose quartz porphyry to felsite outcrops, striking S.S.W. magnetic and with a vertical dip. This outcrop is, however, only about 50 to 100 feet wide.

Keewatin Igneous Rocks in Other Parts of the Field

There remains that part of the field south of Lake Wabigoon, including the Trap lake and Butler lake sections, as well as the Contact bay region, and part of the west shore of Little Wabigoon lake.

In the Contact bay region the rocks representing this series are in contact with Laurentian rocks, and are chiefly acid in character. The most prominent rock type in this locality is a quartz porphyry or dacite porphyry, with small areas of agglomerate, Fig. 8, appearing at various points. Of minor importance are such rocks as altered diabase or basalt, and their corresponding schists, biotite schist, diorite, and altered pyroxenite. Peculiar amygdaloids were encountered in mining claim K. 680, containing prominent amygdules or eyes of quartz. These eyes, being more resistant than the remainder of the rock, protrude in very striking fashion. At the contact between the Keewatin and the Laurentian,

Fig. 8.—Keewatin agglomerate, K 674, Contact bay.

a diorite rock frequently appears between the two formations. This rock shows in thin section a coarse aggregation of hornblende and plagioclase, with lesser proportions of orthoclase, quartz, ilmenite, leucoxene, pyrite, apatite, chlorite, epidote, and limonite. Whether this rock should be put with the other rocks of this series or with the Laurentian rocks, seems somewhat doubtful. However, as it corresponds to the coarse phase of the basic types of the Keewatin, it seems safer to include it in this older series. It is in any case of no very great extent, nowhere being more than 100 feet wide. In this area has been included the small part of the west shore of Wabigoon lake extending from the narrows at the mouth of Contact bay to the south boundary of Van Horne township, the rocks along this stretch of shore being similar to those around the shores of Contact bay. The east shore of these narrows shows rocks of a more basic character, which extend for about a quarter of a mile in both directions from the narrows.

The rocks of the Trap lake section are similar to those at Contact bay, but are also in contact with a later gabbro dike as well as with the Laurentian rocks. Along the south shore of Wabigoon lake as far as Daunais bay the rocks are predominantly acid, with the exception of those outcropping on the large peninsula just west of Daunais bay, where a fairly extensive agglomerate area appears along the shore. The rocks inland are also decidedly acid in character. From Daunais bay along the same shore line to the narrows leading into Little Wabigoon lake, the rocks are for the most part basic in character, the most prominent rock types being altered diabases and basalts and their corresponding schists. A few local outcroppings of the coarse-grained altered pyroxenite appear, but these soon grade into the fine-grained volcanics. This is well shown at one particular point, where it was possible to see the gradation in a single outcrop. A few outcrops of such acid rocks as felsite schists, quartz porphyries, dacite porphyries, and biotite schists also occur. Along the portage from Wabigoon lake to Butler lake a good dacite porphyry occurs, showing in thin section large phenocrysts of quartz, somewhat smaller ones of plagioclase (andesine), and one or two of orthoclase, in a fine-grained matrix of quartz, feldspar, epidote, chlorite, and limonite. This is, however, only a small outcrop. Amygdaloidal rocks are fairly common, the amygdules being chiefly calcite.

The rocks of the series in the Butler lake section, which includes Butler lake and all its tributary lakes and streams, are for the most part basic volcanics. The commonest rock type here is an altered diabase or diabase schist, but areas of agglomerate are fairly numerous, more especially around the shores of Butler lake, Fig. 9, while a few small areas of more acid rocks are also to be found. These basic volcanics show coarse-grained plutonic phases at times, merging into quartz diorites or altered pyroxenites, but such phases are of mere local importance. Many of the rocks are porphyritic or amygdaloidal, while good examples of pillow lava are to be seen in one or two places, as at a point on the west shore of Larson lake, Fig. 10. Most of these rocks carry considerable pyrite, either in the form of small grains or in cubes of various sizes. The Keewatin rocks along the west shore of Little Wabigoon lake as far south as a point due west of the south boundary of the township of Southworth, are decidedly acid in character, being represented chiefly by quartz porphyries, felsites, and their corresponding schists. In general, it may be said of the Keewatin rocks in this part of the field south of Lake Wabigoon, that bands of iron-bearing rock outcrop at infrequent intervals, while most of the other rocks carry some pyrite or limonite.

Keewatin Metamorphosed Sediments

This formation is apparently a border phase of the Keewatin, and is represented by a band from one to five miles wide running roughly from east to west through the northern part of the field. It covers the northern part of Van Horne township, the southern part of Wainright township, and about two-thirds of the township of Zealand, and continues as well on through the neighbouring townships to the east and west beyond the limits of the map accompanying this report. The series, which is in contact with the Keewatin igneous rocks on the south and

Fig. 9.—Keewatin agglomerate, Butler lake.

Fig. 10.—Pillow lava, west shore of Larson lake.

the Laurentian granite on the north, is represented chiefly by hornblende and biotite schists, usually containing a great number of weathered garnet crystals.

A good part of the formation carries a fair amount of magnetite and pyrrhotite, this iron-bearing portion extending along the C.P.R. right-of-way from mile post 66 west of Dryden to the old Barclay station, and from there due east to the east shore of Thunder lake. Unfortunately the iron ore has not been concentrated in economic quantities. On account of this ferruginous band the series has been classed as an iron-formation, but there may be some doubt as to the correctness of this classification, since it differs from the iron-formations described from other localities.

These rocks have been subjected to so many changes that their original character is very difficult to ascertain. However, on account of the occurrence of such metamorphic minerals as garnet, staurolite, sillimanite, and tourmaline, not to mention the banded iron ore, and the fact that quartz is very plentiful while the feldspars are almost entirely absent, one is forced to the conclusion that they have been formed by the metamorphism of a mixed argillaceous and arenaceous sediment. A schist of this series from the vicinity of the pulp mill at Dryden, showed in thin section a laminated aggregation of quartz and biotite, with smaller proportions of magnetite, pyrite, tourmaline, orthoclase, plagioclase, garnet, sillimanite, and zircon, the last-named mineral appearing as tiny inclusions in the quartz crystals. Another schist outcropping along the C.P.R. right-of-way west of Dryden about halfway between mile posts 64 and 65, examined in thin section, consisted chiefly of quartz, hornblende, magnetite, pyrrhotite, and garnet, with apatite and plagioclase as rare constituents. Still another schist taken from lot 3, concession III, Zealand township, showed in thin section chiefly quartz, staurolite, and biotite, with some magnetite, tourmaline, plagioclase, and chlorite. Most of the rocks belonging to this series along the shores of Thunder lake carry much magnetite, pyrrhotite, and garnet. These schists in contact with the Laurentian rocks to the north, sometimes take on a more gneissoid character, as is shown by a rock from concession II, lot 5, Wainright township. This, examined in thin section, was found to consist chiefly of quartz, orthoclase, plagioclase, and biotite, with garnet and magnetite. Similar gneissoid rock was encountered in lot 6, concession I, and again in lot 3, concession I, in the township of Wainright. West of this in the Zealand addition, the regular biotite and hornblende schists are in contact with the Laurentian granite for several miles, the contact being visible in one or two places, while in others these schists outcrop right up to what is quite evidently granite country. It may be noted that the soil in Laurentian territory is for the most part quite sandy, while the overburden carried by the Keewatin sediments is largely white clay. Again, along the C.P.R. right-of-way west of Dryden, the hornblende and biotite schists outcrop fairly close to the Laurentian granite. From this it would appear that the gneissoid rocks are mere border phases of this formation, which are frequently lacking entirely at the Laurentian contact. The contact of this series with the Keewatin igneous rocks to the south was only seen at one place, although at other points the contact is hidden by but a few hundred feet, on the east bank of the Wabigoon river in lot 1, concession V, Van Horne township, about 100 yards north of the line

between concessions IV and V. The schists are cut by many small dikes of muscovite granite or pegmatite, which frequently carry numerous crystals of tourmaline and occasionally one of garnet. The tourmaline is black in colour, except in thin section, where it shows two colours, brown and blue, and is finely pleochroic. These dikes cut the schists in every direction, and vary from 50 or 100 feet to a few inches in width. They are probably outliers from the Laurentian granite, although differing markedly from that granite in composition. The schists vary in strike from N.E. and S.W. magnetic in the western part, to east and west in the eastern part. Their dip is for the most part vertical, although a local variation of 70° to the south was encountered at one point on the shore of Thunder lake. In places these schists have been crumpled and contorted, while in others the banding is very pronounced.

Laurentian

The Laurentian is represented in this field by two areas, one stretching across the northern part, and the other in the southwest corner. The northern area, which is the more extensive of the two, covers all but the southern part of the township of Wainright, the northern part of the Zealand addition, and the unsurveyed territory north and east of Bad Rice lake. Its contact with the Keewatin sediments is very irregular in outline, but runs roughly east and west. The formation is represented here by a typical biotite granite. This rock shows a very rough foliation in a few places, but is for the most part not at all gneissoid in character. A granite from lot 5, concession II, Wainright township, examined in thin section, consists chiefly of a coarse aggregation of quartz, orthoclase, plagioclase, biotite, muscovite, and epidote, with minor quantities of magnetite, apatite, and chlorite. In places small fragments of the Keewatin sediments are included in the granite some distance from the contact. In other places, as at a point just east of the eastern end of the line between concessions I and II, Wainright township, this granite is fresher in appearance, the feldspar being quite pink in colour. It also carries some garnet crystals. This northern area extends north of the boundaries of the accompanying map. The writer was able to see outcrops of this formation as far north as Gull lake, where it is in contact with the hornblende-biotite schist series. The pegmatite dikes, already mentioned as cutting these schists, are larger and much more numerous at this locality, but do not extend into the Laurentian granite.

The southern area of this formation appears in the Contact bay region, surrounding the western end of that bay, and extending over to Little Pickerel lake. The rocks are in contact here with both the Keewatin igneous rocks and a later gabbro dike, the latter along the shores of Little Pickerel lake. The contact with the Keewatin rocks is well shown on a small island in Contact bay called Contact island, Fig. 11, where the Laurentian granite is aplitic in texture. In thin section this aplite or quartz porphyry shows a great many phenocrysts of quartz as well as a few of both orthoclase and plagioclase, in a fine-grained matrix consisting chiefly of quartz and orthoclase, with hornblende pyrite, epidote, kaolin, and limonite. The contact is also shown in some of the mining locations west of the Rognon camp. This is the case along the western boundary of K. 644,

where the peculiar dioritic rock already mentioned occurs between these two formations. A Laurentian granite from a point west of the western end of Contact bay, examined in thin section, showed chiefly a coarse aggregation of quartz, microcline, orthoclase and albite, with biotite, muscovite, calcite, and apatite. This Laurentian-Keewatin contact is again seen at a point near the northeast corner of Little Pickerel lake, where a coarse granitic rock lies up against a fairly basic Keewatin rock. The granite, examined in thin section, consisted chiefly of quartz, orthoclase, albite, and hornblende, with minor quantities of epidote, apatite, and magnetite. The feldspars, the hornblende, and the magnetite have been altered in places to kaolin, chlorite, and limonite respectively. This rock appears to be a typical hornblende granite. Along the south and west shores of Little Pickerel lake this formation is again represented by the regular biotite granite. The contact between the Laurentian rocks and the later gabbro dike, outcropping around the shores of this lake, is unfortunately hidden by overburden.

Fig. 11.—Contact between Laurentian and Keewatin, Contact island, Contact bay.

Later Granite

This formation is represented by two comparatively small areas. One is in the northwest corner of Southworth township, and outcrops along the shore of Wabigoon lake in the vicinity of Wabigoon station, and also on one or two of the islands opposite this bit of shore. The area likewise extends for a very short distance into concession I of the township of Zealand. This outcrop is a mere fringe along the shore line, and does not cross the C.P.R. right-of-way as shown on a former map. No rock outcrops of any kind are to be seen on the section of track indicated, nor on that part of the Dinorwic road just beyond the track. This rock is found on several of the islands in the neighbourhood, the granite here appearing as small dikes in the Keewatin rocks, Fig. 12. Apparently, the dikes are small outliers from the main body. The contact between this granite and the Keewatin

rocks is shown on the mainland at both the north and south ends of the outcrop. The Keewatin here is quite basic in character. The granite is of the hornblende-biotite variety; a specimen in thin section showed a coarse aggregation of quartz, albite, orthoclase, microcline and epidote, with hornblende, biotite, apatite, and magnetite. It differs from the Laurentian granite in being much fresher in appearance, and also in containing considerable microcline. The feldspar is uniformly pink in colour, a fact which may be noted even from a distance.

The other smaller area of later granite outcrops around the east shore of Wee Sandy lake in Southworth township. It apparently consists of a fringe only, and does not appear to extend for any distance inland. The granite is similar to that on the shore of Wabigoon lake, except that it contains more hornblende and biotite. It also appears to be even less altered than the other granite.

Fig. 12.—Granite outliers in Keewatin rock, island in Wabigoon lake, west of concession 6, Southworth township.

Other Later Dikes

There are four of these dikes in all, three of them small. One of them is intermediate in character, the other three basic. At least two of them, and probably all four, are Keweenawan in age.

The first outcrops along the portage between Pritchard and Flambeau lakes in the southwest corner of Van Horne. This is a diabase dike about 200 yards long and about 200 feet wide. Near the west end the dike branches off into two or three smaller dikes. The dike rock shows in thin section a decidedly ophitic structure, with plagioclase (labradorite), pyroxene, and magnetite as the main constituents, and pyrrhotite, hornblende, and limonite present in minor quantities. Many of the pyroxene crystals have been altered to hornblende, either partially or completely, by a process of uralitization. The rock is comparatively coarse in texture, except at the contact with the surrounding rock, which is Kee-

watin agglomerate, where it is very dense but still retains its diabasic structure. The contact between the dike and the Keewatin rocks is very pronounced, as the dike rock is decidedly dark in tone, while the surrounding rocks are light in colour, Fig. 13. The dike, which is not at all schistose in character, strikes east and west. At various points along its length fragments of the Keewatin agglomerate are included in it, showing conclusively that the dike rock is younger than the agglomerate. It seems extremely likely that this dike is Keweenawan in age, as its petrographic characters are almost identical with rocks of this formation seen by the writer in other localities.

Another dike of exactly similar nature was encountered on the 18-chain portage on Pichenninnis creek, south of Butler lake. It also strikes east and

Fig. 13.—Contact between diabase dike and Keewatin agglomerate, southwest corner of Van Horne township.

west, outcrops for a distance of about a quarter of a mile, and is about 100 yards wide. In petrographic character it is identical with the dike in the neighbourhood of Flambeau lake.

A still larger dike was encountered on the shores of Trap and Little Pickerel lakes. It covers a considerable area, extending from the south end of Little Pickerel lake to the north end of Trap lake and beyond. Its general strike is north-northeast. The dike is basic, varying from an altered gabbro or norite to an altered pyroxenite or anorthosite. A thin section taken from the north shore of Little Pickerel lake showed chiefly highly chloritized hornblende, together with magnetite, calcite, serpentine, and limonite. Fluorite is a rare constituent.

of this rock, which appears to be an altered pyroxenite. Another thin section from the west shore of the same lake showed an ophitic mass of plagioclase (labradorite) and highly altered hornblende, with lesser quantities of pyroxene, pyrite, chlorite, epidote, and limonite. The hornblende has quite evidently been formed from the alteration of pyroxene crystals by the process of uralitization, as remains of the old pyroxene are to be seen in the centres of some of the crystals. The rock seems to be an altered diabase or gabbro. A third thin section taken from the north shore of Trap lake exhibited a coarse aggregation of plagioclase (labradorite) and enstatite, the former predominating. Small amounts of sericite and chlorite are also present in this rock, which appears to be a gabbro or norite. Still another specimen of this dike, from the east shore of Trap lake at the contact with the Keewatin rocks, consists almost entirely of plagioclase (labra-

Fig. 14.—Spheroidal weathering in basic dike, Little Pickerel lake.

dorite), with but minor quantities of magnetite, hornblende, epidote, chlorite, and limonite. This rock seems to be an anorthosite, and represents the acid extreme of the dike. The contact between the dike and the Keewatin rocks is shown in only two places. On the east shore of Trap lake the contact with the basic volcanics of the Keewatin is well shown, the latter outcropping beside the dike with a good line of demarcation between. A similar contact is seen at a point about a quarter of a mile west of the western shore of Little Pickerel lake, where the Keewatin is again represented by a basic volcanic. The contact between this dike and the Laurentian granite is unfortunately hidden by overburden. A peculiar form of spheroidal weathering is exhibited by the dike rock. This is particularly well shown on the large island in the middle of Little Pickerel lake, Fig. 14. Here the rock weathers to bomb-like spheres, which in the process become separated

from the remainder of the outcrop, so that the shores are strewn with them. On the north and west shores of Trap lake numerous small aplite dikes cut this later gabbro dike. They are very small, the largest being about two feet wide. A specimen taken from one of these dikes, and examined in thin section, presented an interesting micrographic intergrowth between the quartz and the feldspars. The rock consisted chiefly of a fine-grained aggregation of quartz, kaolinized feldspars, both orthoclase and plagioclase, and epidote, with some hornblende. These dikes probably represent an acid phase of the gabbro dike.

Still another dike appears on the north shore of Wabigoon lake on the peninsula on the west side of Barritt bay. It outcrops on both sides of the peninsula, strikes west-northwest, and is about 10 feet wide at its widest part. The rock is intermediate in character, corresponding best to a porphyritic biotite diorite. In thin section it shows large phenocrysts of plagioclase (andesine), in a fairly coarse matrix consisting chiefly of plagioclase and biotite, but containing also minor amounts of quartz, epidote, magnetite, and apatite. Calcite is a rare constituent. The dike is in contact with Keewatin rocks of basic composition. Beside these, there are several very small basic dikes in different parts of the field. They are so small that they cannot be mapped, but they deserve a passing mention. In composition they are very dense diabases, being similar in character to the border phase of the diabase dike in the neighbourhood of Flambeau lake. One of these dikes is on the east shore of Little Pickerel lake cutting Keewatin rocks, another at the northwest corner of Trap lake cutting the large basic dike. Still another outcrops on the east shore of Paulson lake, cutting basic Keewatin rocks at this point.

Veins and Vein Minerals

The veins in this region are confined almost entirely to the igneous division of the Keewatin formation, although a few occur also in Laurentian rocks. Quartz veins are to be found in these Keewatin rocks in almost any part of the field, but are particularly numerous in the vicinity of the Laurentian area in the south-west corner. This would seem to show that the granite played a prominent part in their deposition. For the most part the veins follow the direction of schistosity in the rocks, although occasionally they cut across it. They vary in width from a few inches to 20 feet or more. The vein material is largely white quartz, but ankerite, pyrite, and black tourmaline are quite plentiful, while chlorite, chalcopyrite, malachite, azurite, hematite, and native gold are rarer constituents. Black tourmaline is especially plentiful in the veins in the south part of Van Horne township, where it occurs in the quartz in the form of small needles. In some places in the western part of the field the quartz is heavily rusted with iron oxide, a good example of this being the vein material from the main Rognon vein on Contact bay. On mining location K. 611 the mineral covellite appears in a quartz vein associated with pyrite and chalcopyrite. The covellite forms a coating over the other sulphides.

Mining Properties

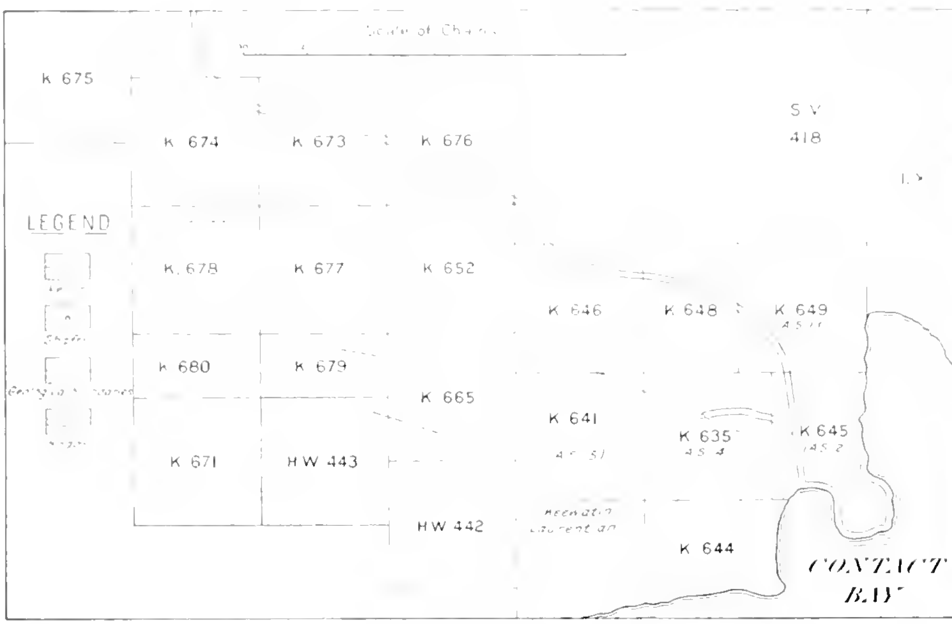
Under this heading will be included only those properties on which some work has been done in recent years. Most of the properties are situated in the western part of the field, although a few were opened up in the eastern section.

Redeemer Mine

Apart from an attempt to unwater the shaft in the summer of 1910, nothing has been done with this property in recent years. Fig. 15.

League Mine

This property has not been worked since the summer of 1914. There are three shafts, Nos. 1 and 2 in the north half of lot 6, concession 1, and No. 3 in the



Sketch map showing mining locations and position of veins, northwest shore of Contact bay, Wabigoon lake.

north half of lot 5, concession 1, Van Horne township. Nos. 1 and 2 have been sunk to a depth of 80 feet, and No. 3 to a depth of 20 feet. The latter is situated near the shore of Larson bay, and was sunk in the summer of 1914. The vein material shown on the dumps is the same at all three shafts, consisting chiefly of quartz, ankerite, tourmaline, and pyrite, with green mica and chalcopyrite. The country rock at all three shafts is a very dense felsite or quartz porphyry, considerably sheared and brecciated in places. No. 2 shaft is equipped with a 45 h.p. boiler, a small hoist, and a 1-stamp mill, while No. 3 shaft is equipped with a 12 h.p. boiler and a small hoist. The mine buildings, which are in charge of Messrs. A. Pitt and G. Larson, of Dryden, are in good condition. Fig. 16.

Good Luck Property

No further sinking has been done on this property since it was last reported upon, but tests were made for the Dominion Reduction Company during the summer of 1916.

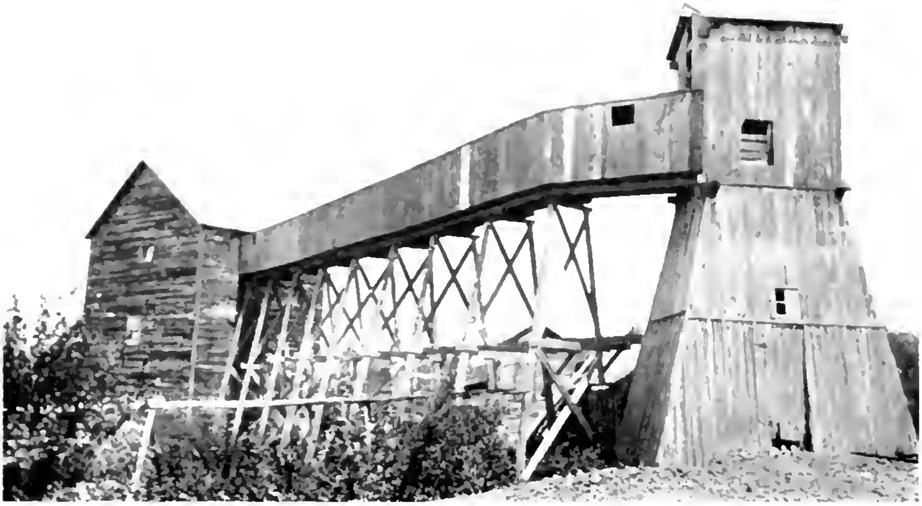


Fig. 15.—Redeemer mine shaft and mill.

Fig. 16.—No. 3 shaft, League mine, Larson bay.

Other Properties in Van Horne Township

On the Lost mine, which is situated in the north 80 acres of the south half of lot 6, concession I, and which has been mentioned in previous reports, considerable additional stripping has been done between the two shafts.

On the old Drake property immediately adjoining the Good Luck property to the west in the northeast corner of lot 9, concession I, three shafts have been sunk along the line of the Good Luck vein. These are respectively, 52, 12, and 10 feet in depth. The vein material at all three shafts is quartz, ankerite, tourmaline, chlorite, and pyrite. Considerable stripping has also been done between the shafts.

In the northwest corner of mining location A.L. 88 on the shore of [illegible] lake in the southwest corner of the township, a small test pit has been sunk on a stock-work of small veins, the vein material consisting of quartz, ankerite, pyrite, and tourmaline.

In the northeast corner of the adjoining location, A.L. 90, another test-pit has been sunk on the same material. The country rock at both these pits is an altered diabase schist.

North of this on mining location R. 544, near the shore of Pritchard lake, a test-pit has been sunk to a depth of about four feet in a dense felsitic rock containing numerous small quartz stringers, most of them following the strike of the rock, but some of them cutting across it. The quartz is impregnated with pyrite, and also contains small amounts of chalcopyrite, ankerite, and tourmaline.

In the same area, in the northern part of mining location H.W. 516, a test-pit has been sunk to a depth of about 8 feet on a banded felsite schist, carrying quartz, pyrite, and ankerite. On the claim immediately adjoining this last one to the east two other test-pits have been sunk, one about 10 feet deep on the same sort of material as on H.W. 516, the other three or four feet deep on a stock-work of small quartz veins, the whole mass of both veins and rock being impregnated with pyrite and containing as well small amounts of chalcopyrite, feldspar, tourmaline, and hematite. This stock-work has been traced for a width of about 30 feet and a length of 20 feet, some of the stringers following the strike of the rock, other cutting across it. The pit is said to have shown some gold values.

In the northeast corner of lot 11, concession I, two shafts have been sunk by the Cleveland Mining Company. The first of these, which is situated only a short distance from the corner post between lots 10 and 11, is about 20 feet deep, and has been sunk on a small vein three to six inches wide, consisting chiefly of quartz, ankerite, tourmaline, and pyrite. The country rock at this shaft is an altered diabase. This shaft is equipped with a small windlass. The other shaft on this property, which is situated about a quarter of a mile west of the first one, is 85 feet deep, and has been sunk on the same sort of material and in the same country rock. Several old mine buildings, including the remains of an old mill, are still standing near this shaft, but all the equipment has been removed.

Properties in the Vicinity of Contact Bay

These properties are situated, for the most part, on the west side of Contact bay in Keewatin rocks, close to the contact with the Laurentian granite. A few, however, are found in other parts of that immediate neighbourhood, one even adjoining the south boundary of Van Horne township.

Rognon Property (K 635)

This is the old mining location A.S. 14, situated on the north side of Contact bay, and is the property on which the gold discovery was made, that recently attracted attention to this area. The vein runs in a general way N. 68° W., starting near the eastern boundary of the claim and crossing it diagonally. It also continues across the northeast corner of K. 641 and on into K. 646. It follows in a general way the strike of the country rock, which is a biotite schist with a vertical dip. It varies in width from two feet to two inches, pinching and swelling alternately throughout its length. The vein material is a reddish quartz, highly impregnated with hematite, and occasionally carrying a little pyrite. At a point 642 feet from the west boundary of the claim, the distance being measured along the strike of the vein, a shaft has been sunk to a depth of 23 feet, Fig. 17. The vein here is one foot wide at the surface and one and a half feet wide at the bottom of the shaft. Two other test-pits have been sunk at other points along the vein, one seven feet and the other three or four feet deep. Stripping has also been done along the whole length of the vein on this property, as well as for some distance beyond its southeastern limit. In places the vein splits into several tiny stringers of quartz, with horses of country rock between. It was proposed to erect a 1-stamp mill in the vicinity of the vein for the purpose of testing the ore before putting up a more extensive plant. This, however, has not been done as yet. The shaft is equipped with a small windlass. The property is owned by E. G. Rognon, of Dryden. The mine buildings are situated on the adjoining claim K. 645 on the shore of Contact bay, Fig. 18. A description of this property has been given by James Bartlett.[1]

Other Properties Near Contact Bay

West of this last property is mining location K. 641 (A.S. 15). On this property a vein has been located striking N. 37° E. and dipping at an angle of 45° to the southeast, which cuts across the strike of the country rock. This vein, which has been stripped for a distance of 150 feet, has a uniform width of one and a half to two feet. The vein material is chiefly reddish quartz, but pyrite, covellite, and chalcopyrite are present in considerable quantities, the covellite forming a beautiful blue coating on the other sulphides. No gold values of any account were obtained.

The vein from the Rognon property (K. 635) continues through the northeast corner of K. 641 and on into K. 646, keeping to the same general direction. Stripping has been done along this continuation for a distance of 2,300 feet northwest from the point where the vein crosses the west boundary of K. 635, but the vein itself continues for only 1,600 feet of this distance. Only small isolated stringers occur beyond this point, which are not real continuations of the vein. This claim, K. 646, is owned by G. Larson and B. Stewart, of Dryden, and considerable assessment work was done on it during the summer of 1916.

Of the other claims in this group assessment work was done on K. 673, K. 674, K. 675, K. 677, K. 678, K. 679, and K. 680 during the summer of 1916, and numerous small quartz veins were located. These properties are also owned by E. G. Rognon, of Dryden.

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[1] "Gold Discovery near Dryden," by J. Bartlett, Can. Mining Journal, Dec. 1, 1915.

Fig. 17.—Shaft on Rognon property, K. 635, Contact bay.

Fig. 18.—Rognon camp, Contact bay.

A vein carrying tellurides and bismuthinite, and showing small gold values, was also located in November, 1916, running across mining claims K. 665 and H.W. 443.

A road has been constructed, since the departure of the writer from this field, from the road between the League mine and Dryden down to the shore of Contact bay through these properties. Its location is shown on the accompanying map.

To the west of the western end of Contact bay are situated two old mining locations, known respectively as the Long Lead and American Jack claims.

The Long Lead property includes two forty-acre claims. Through these two claims runs a large quartz vein in the general direction N. 10 W. magnetic varying in width from 4 to 22 feet. It carries pyrite and chalcopyrite, but no gold values of any account. The country rock here is a basic Keewatin volcanic.

The American Jack property is south of the last location. A shaft has been sunk on this property to a depth of about 60 feet on a few quartz stringers in Laurentian granite and gneiss. The material on the dump is largely granite.

On the south side of Contact bay two properties have been located. On the first of these, E.D.B. 1 (S. 224), the larger of the two, two shafts have been sunk to a depth of 25 and 35 feet respectively on a quartz vein, about five feet wide at its widest part, which is at the deeper shaft. The vein material here is entirely quartz, and the country rock is a Keewatin quartz porphyry.

On the same side of Contact bay, the claim adjoining the last mentioned one to the east is S. 622. The north 40 acres of this long narrow claim was re-staked during the summer of 1916 for M. S. Campbell, of Dryden. The rock on the new claim is a dense quartz porphyry, and contains several small veins of quartz. The widest of these veins is one to one and a half feet in width, and has been stripped for a distance of 50 to 100 feet.

Mining location S.V. 372, adjoining the southern boundary of Van Horne township, has had its shaft deepened to 60 feet. Two mill-tests of the ore from this property were made in the summers of 1913 and 1914.

Properties in the Eastern Part of the Field

On the extreme northern shore of Butler lake several mining locations have been taken up. On one of these, two small shafts have been sunk, the first on a tangle of quartz stringers containing pyrite, ankerite, tourmaline, chalcopyrite, and malachite, the second on a quartz vein about 4 feet wide, containing the same vein material as at the first shaft. The country rock at the latter is a felsite schist striking about northwest, while that at the second shaft is an altered diabase.

Northeast of the town of Wabigoon is mining location H.W. 130, known as the Northern Queen mine. On this property a shaft has been sunk to a depth of 60 feet on a quartz vein carrying considerable pyrite. This vein, which is one to three feet wide at the shaft, strikes north-northwest and has a vertical dip. The country rock, which is heavily stained with iron oxide, is a diabase altered to diabase schist, striking about east and west, and with a vertical dip. As far as

could be ascertained, no gold values of any account were obtained from this vein. This property has not been in operation for several years, but as no description of it appears in any previous report, a brief mention of it seemed advisable.

On the first large headland west of Wabigoon station on the west side of Barritt's bay in Lake Wabigoon, J. Aaron, of Wabigoon, has sunk a shaft 50 feet deep on a series of small acid dikes running in the same general direction as the strike of the surrounding rocks. The shaft is situated on the west side of this headland. These dikes, which carry small quantities of pyrite and tourmaline, are felsitic in character, and penetrate a basic Keewatin volcanic rock. The small acid porphyritic dike, already mentioned in connection with the later dikes, outcrops in the vicinity of this shaft. At a point about in the centre of this same headland some talcose rock occurs. This rock is composed chiefly of impure talc, which may be readily cut with a hack-saw, but is evidently merely an altered phase of the Keewatin basic rocks. This is a fairly extensive outcrop, but the talc appears to be too impure, for the most part, to be of economic value. Some little crystallized talc also occurs in small veins.

Molybdenite

This mineral was found in four separate localities, two of them within the limits of the accompanying map (No. 26e,) and two outside.

In the extreme northeast corner of mining location K. 614, a small quartz vein occurs at the contact between the Laurentian granite and the Keewatin rocks. It contains small plates of molybdenite, as well as lesser quantities of pyrite and chalcopyrite. It is a very narrow stringer, and does not continue for more than a few feet. The largest plates of molybdenite here are only one-half to three-quarters of an inch in diameter.

In the claim to the north of this last one, K. 615 (A.S. 12), on the point south of the cabins at the Rognon camp, a little molybdenite is to be found near the water's edge. It occurs here in tiny flakes in quartz stringers in Keewatin rock, and also sprinkled through the rock itself. A little pyrite, chalcopyrite, and malachite are associated with the molybdenite. Besides these two occurrences of the mineral, two other molybdenite properties were visited by the writer for A. L. Parsons. These are both outside the limits of the accompanying map, one in the neighbourhood of Gull lake and the other in Upper Manitou lake district. Detailed descriptions of these two properties will be found in the report on molybdenite deposits in Ontario by Mr. Parsons in this volume. Some passing reference, however, must be made to the association of bismuthinite with the molybdenite on the property in the Manitou district. The bismuthinite here resembles stibnite in its mode of occurrence, appearing in the form of long slender needles, with a good metallic lustre on fresh fracture surfaces, but tarnishing to a dull brown colour on exposure.

Molybdenite has also been reported from Granite lake in Lower Manitou lake district, but the writer was unable to visit this deposit. Samples from this locality showed purple fluorite associated with the molybdenite.

Scheelite has also been reported from the vicinity of Lower Manitou lake, on mining location H.P. 303.

A trip was made by the writer with P. Kirkegaard, of Toronto, to the Laurentian property near the former town of Gold Rock. The Big Master and Jubilee mines were also revisited.

Fig. 19.—Wabigoon river at Dryden pulp-mill, below dam.

Fig. 20.—Rapids in Wabigoon river below C. P. R. bridge, showing power station.

Water Power

The Wabigoon river has two falls in its course through the town of Dryden, these supplying the power for the operation of the plant belonging to the Dryden Timber and Power Company. Undoubtedly more power could be developed here for the operation of mining plants, although no such use of this power has been made up to the present time. Figs. 19 and 20.

Acknowledgments

In conclusion, the writer wishes to acknowledge the kind assistance rendered to him by everyone with whom he came in contact while working in this field. Space does not allow the enumeration of all the names he would like to mention in this connection, but special thanks are due to E. G. Rognon and Mrs. Rognon, with whom he stayed during the first month in the field, and whose valuable aid on many occasions facilitated the work, both while on the ground and also in the compilation of this report. A. Pitt, G. Larson, A. McPhail, and D. Hutchison, of Dryden, should also be thanked for valuable help rendered during the summer. To E. D. G. Pidgeon and Mrs. Pidgeon, of Wabigoon, the writer and his party are indebted for much help while in their vicinity, and to J. Aaron, of Wabigoon, and J. Fraser, of Keewatin, for information as to the roads of this locality. Finally, the writer wishes to thank Dr. A. P. Coleman, Dr. T. L. Walker, and Prof. A. L. Parsons, of the University of Toronto, for valued advice on the geology of this area. Through the kindness of Wm. McInnes, of the Canadian Geological Survey, the writer was enabled to use Map No. 720, Rainy River district, Manitou Lake sheet, as a base map.

THE KOWKASH GOLD AREA

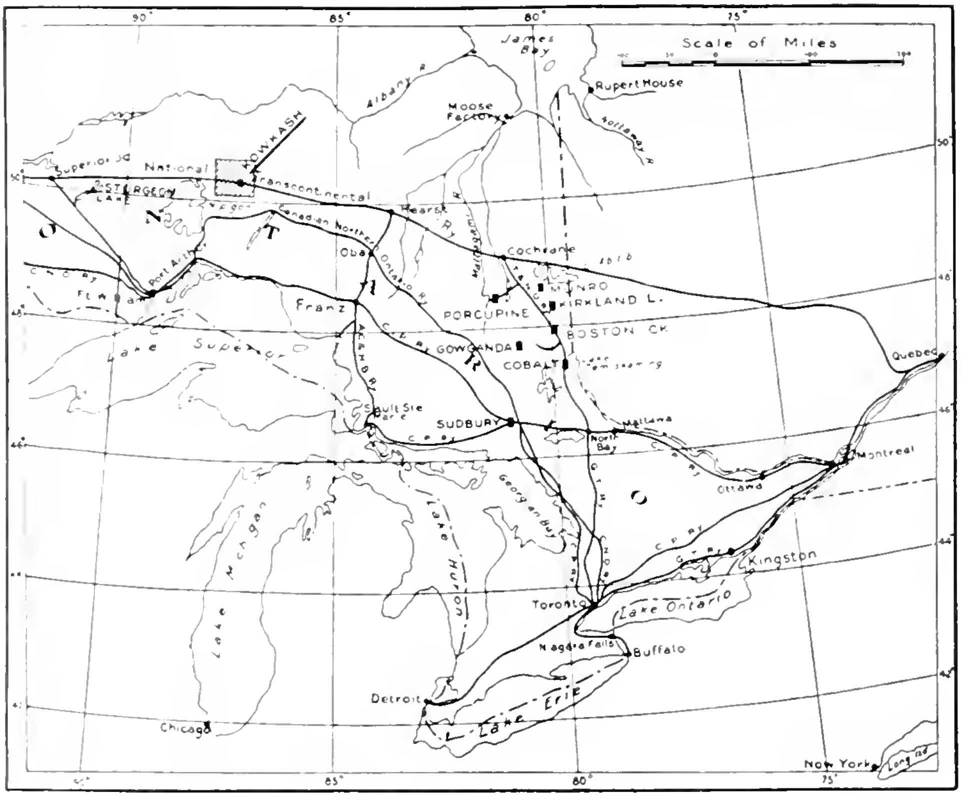
(SECOND REPORT)

By P. E. HOPKINS

I. INTRODUCTION

Location and Area

The following report deals with the topography, geology and economic resources of a region lying to the northeast of Lake Nipigon in the newly created Kowkash Mining Division, Thunder Bay district. The area examined, covering about 1,100



Sketch map of Ontario, showing Kowkash gold area.

square miles, as shown on the accompanying map, is located between 50° 3′ and 50° 32′ north latitude and 86° 58′ and 87° 58′ west longitude, along the height of land separating Hudson bay and Lake Superior waters. Until a few years ago the area could only be reached by canoe, the nearest railway being the Canadian Pacific, 80 miles to the south. The completion of the National Transcontinental railway through the region in 1913 has made the country accessible and given prospectors entry to an area of which little was previously known, with the exception of the Onaman iron range embracing a few square miles on the head waters

of the Onaman river. The finding of a spectacular gold showing by E. W. King Dodds at Howard falls, nine miles north of Kowkash station, on August 21st, 1915, caused a rush of prospectors to the neighbourhood, which resulted in other gold finds being made along the Kawashkagama (Kowkash) river and in the vicinity of Tashota station, 25 miles to the west of Kowkash. Tashota, which is 320 miles west of Cochrane, can be reached in 28 hours from Toronto by Pullman train.

Accompanying this report is a coloured geological map of the area on a scale of two miles to the inch.

Early Exploration

Robert Bell, when examining the country north of Lake Superior in 1870 for the Geological Survey of Canada, got as far north as Wawong portage on the Kawashkagama river where Cavell station is now situated. The following year, 1871, he made a survey with micrometer and prismatic compass of the Ombabika river when en route to the Albany river.

In 1900 the Department of Crown Lands sent into northern Ontario, in charge of Ontario land surveyors, ten exploration parties, two of which traversed portions of this map-sheet. Joseph M. Tiernan, in charge of party number 6, with A. H. A. Robinson as geologist, travelled the Ombabika river and Robinson lake on their way farther north, while party number 5, with W. S. Davidson, surveyor, and E. V. Neelands, geologist, examined an area further east and reached as far north as Howard falls on the Kawashkagama river. Mr. Neelands in his report stated:

> Huronian [Keewatin] rocks, mainly chlorite and other soft green schists, occur on the Kawa-kash-kagama [Kawashkagama] river for about four miles below the Wawong portage to the northern limit of exploration [Howard falls]. . . . The most promising district is the country on the Kawa-kash-kagama [Kawashkagama] river below the Wawong portage. Here Huronian [Keewatin] exposures are numerous, mostly chlorite and other soft green schists. Several samples from small quartz veins in this district showed traces of gold, and it might be that careful prospecting in this district would be rewarded.

In 1902 W. A. Parks explored part of this region and made track surveys for the northeast quarter of the Nipigon sheet.[1]

During 1903 W. J. Wilson, assisted by Owen O'Sullivan, surveyed the Nagagami and other branches of the Kenogami river; also the Little Current river to within 25 miles of O'Sullivan lake. The next year Mr. Wilson, assisted by W. H. Collins, continued the work done in 1903, and connected the survey from Howard falls on the Kawashkagama through O'Sullivan lake and for 25 miles below, joining the survey of the previous year on the Little Current river. They also followed the series of lakes and portages northeastward from Wawong to Eskegenaga lake. The result of the two years' work was published in the Geological Survey publication No. 980, accompanying which is a map (No. 964) on a scale of 8 miles to 1 inch.

Between 1903 and 1908 numerous trial lines were run through this area for the National Transcontinental railway, which line was completed in 1913.

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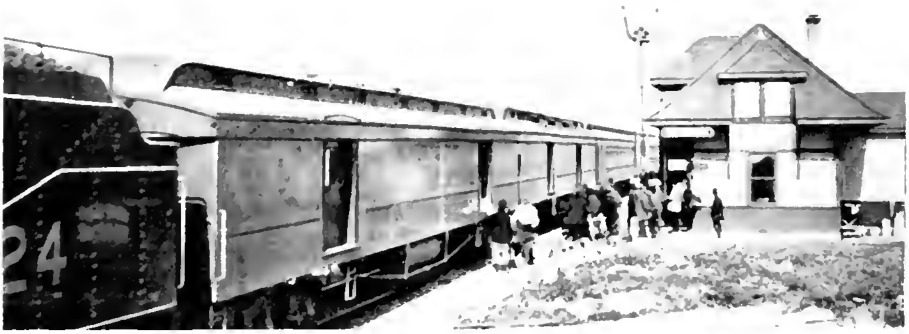
[1] Geological Map No. 8 A, scale 4 miles to the inch, accompanying Memoir No. 1, Geol. Sur. Can., 1910.

In 1907 and 1908 E. S. Moore mapped in detail the Onaman Iron range, which lies along Johnson creek near where Kowkash and Paska stations are now situated.

In 1908 A. W. G. Wilson, assisted by Robert Harvie, Jr., completed the

Kowkash station, National Transcontinental railway, September, 1915.



Tashota station, National Transcontinental railway, June, 1917.

geological details for the Lake Nipigon map (No. 8a), Mr. Harvie having examined some small lakes to the east of Cross lake.

In the autumn of 1915 the writer visited the area and examined the various gold discoveries north of Kowkash on the Kawashkagama river and near Tashota.

Kowkash Mining Division

Owing to the large number of claims that were staked in the rush following the King-Dodds discovery, a mining division was formed, with the Mining Recorder's office at Tashota. According to the Order-in-Council, dated May 25th, 1916, approximately 1,700 square miles were detached from the Port Arthur Mining Division for the new Kowkash Mining Division, the boundaries of which are described as follows:

Commencing at the southeast angle of the township of Henderson, being a point in the boundary line between the districts of Algoma and Thunder Bay, 71 chains 18 links north of the 93rd mile post on said district line; thence west astronomically along the south boundaries of the townships of Henderson, Selwyn, Barlow, Goodwin, Chipman and Raynar, 34 miles more or less to the southwest angle of the last mentioned township; thence continuing west astronomically 67 miles more or less to a point on the shore of Lake Nipigon at or near Humboldt Bay; thence in a general direction northwesterly, westerly, and southwesterly, following the shore line of Lake Nipigon in all its windings to the Wabinosh River, where it enters Wabinosh Bay of said Lake Nipigon; thence northwesterly following the south shores of Wabinosh Lake, Waweig or Round Lake, Sucker Lake, Valley Lake, Clear Lake, Tunnel Lake, and connecting streams to the west boundary of the Nipigon Forest Reserve; thence north astronomically along said west boundary of the Nipigon Forest Reserve and continuing north astronomically 85 miles more or less to the south shore of the Albany River; thence in a general course easterly along the south shore of said Albany River to its intersection with the boundary between the districts of Thunder Bay and Algoma; thence south astronomically along the said district boundary line 110 miles more or less to the point of commencement.

Mark R. Morgan of Port Arthur was appointed Mining Recorder of the said division, and has been doing business since June, 1916. Tashota is a station on the Transcontinental railway, and now has also a telegraph operator, express office and post office.

Surveys

Prior to the autumn of 1915 the only surveyed lines in the area were the numerous trial lines which were run between 1903 and 1908 for locating the National Transcontinental railway. These lines were not of any value to the writer since a large scale map showing their location could not be obtained. In November, 1915, R. S. Code, O.L.S. ran a line north from Paska station to locate Howard falls and numerous gold-mining claims in the vicinity. This line was connected eastward along the railway for 38 miles to Raynar township. The eastern boundary of the Nipigon Forest Reserve was run by Phillips and Benner of Port Arthur in 1916. The railway through the area westerly from O.L.S. Code's meridian line was traversed with chain and transit by the writer and party in 1916 for base-line purposes. No mining claims were surveyed in 1916.

Method of Field Work

The summer of 1916 was spent in examining the area, most of the time being devoted to making a topographical map. This necessitated slighting, to some extent, the complicated pre-Cambrian geology, and for this reason the report must be considered preliminary in character.

The survey of the waterways and the geological examination of the shore lines were carried on together. Instrumental surveying was done by means of a micro-

meter and prismatic compass and tied to one of the following chain-and-transit survey lines, viz.: the railway, R. S. Code's lines from the railway to Howard falls, and the east boundary of the Nipigon Forest Reserve. The sun-dial compass was used in surveying parts of Johnson creek and the Onaman river where iron formation is abundant. Occasional astronomic observations for azimuth and latitude were taken.

The geological work away from the water courses, railway and survey lines was carried on by making compass and pacing traverses on foot through the woods. This necessitated much labour owing to the absence of roads or trails, and the bad tangles of fallen and partly burned trees.

Approximate altitudes of lakes were obtained by measuring the drop of the falls and rapids by hand and reconnaissance levels, and connecting these observations along the canoe routes with the established levels on the National Transcontinental railway.

Method of moving canoes and camp supplies along the railway, Johnson creek crossing, August, 1916.

Acknowledgments

E. W. Todd, W. S. Dyer, A. C. Wheatley and P. A. Jackson, O.L.S. acted as efficient assistants during the season. In addition Mr. Jackson prepared the accompanying map.

The assays and analyses mentioned in the report were made by W. K. McNeill, Provincial Assayer, and his assistant, T. E. Rothwell.

The photomicrographs were taken by C. W. Knight.

The writer is indebted to numerous prospectors for assistance, and to Mark R. Morgan, Mining Recorder at Tashota, for maps of recorded claims, etc.

Bibliography

Bell, Robert.

"Report on the Country north of Lake Superior, between the Nipigon and Michipicoten Rivers," Geological Survey of Canada, Report of Progress, 1870-71, pp. 322-351.

"Report on the Country between Lake Superior and the Albany River," Geol. Sur. Can., Report of Progress, 1871-72, pp. 101-114.

HOPKINS, P. E.
"Kowkash Gold Area," Ont. Bur. Mines, 1916, Vol. 25, Part I, pp. 269-274.
MOORE, E. S.
"Iron Ranges east of Lake Nipigon. The Onaman Iron Ranges," Ont. Bur. Mines, Vol. 17, 1908, pp. 170-189.
"Geology of the Onaman Iron Range Area," Ont. Bur. Mines, Vol. 18, 1909, pp. 196-25
NEELANDS, E. V.
"Report of the Geologist, Party No. 5, Report on the Exploration of Northern Ontario," Ontario Department of Crown Lands, 1900, pp. 147-157.
PARKS, W. A.
"Region lying Northeast of Lake Nipigon," Geol. Sur. Can., 1902, New Series, Vol. XV, Part A, pp. 213-222.
"Report of 1902 on the Geology and Natural Resources of the Northeastern Nipigon District," Geol. Sur. Can., Manuscript Report (unpublished), 1902.
ROBINSON, A. H. A.
"Report of the Geologist, Party No. 6, Report on the Exploration of Northern Ontario," Ontario Department of Crown Lands, 1900, pp. 162-172.
WILSON, A. W. G.
"Geology of the Nipigon Basin," Geol. Sur. Can., Memoir No. 1, 1910, pp. 1-152.
WILSON, W. J.
"Geological Reconnaissance of a Portion of Algoma and Thunder Bay District," Geol. Sur. Can., 1909, publication No. 980, pp. 1-15.
"The Nagagami River and other Branches of the Kenogami," Geol. Sur. Can., Vol. XV, 1903, pp. 109-120 A.
"The Little Current and Drowning Rivers, Branches of the Albany, East of Lake Nipigon," Geol. Sur. Can., Vol. XVI, pp. 164-173 A.

II. GENERAL CHARACTER OF THE AREA

Topography

The area has an average altitude of about 1,000 feet above sea level. The topography in general is flat, with a maximum difference of not more than about 100 feet between the hills and the valleys. Some three miles to the west of O'Sullivan lake is an unusually large, cone-shaped hill which is conspicuous from O'Sullivan, Abamasagi and Eskegenaga lakes and the King-Dodds claim. The more rugged parts of the area are along the Ombabika waters below Cross lake, and around Willet and Albert lakes which lie to the east of Cross lake. The highest altitude in that locality is the granite hill 300 (?) feet in height on the south shore of Cross lake. This prominence can be seen from Summit lake and other points. On the whole, the country has one general level, showing that the various types of rocks have had no great influence on the topography. This is in a youthful stage, as shown by the deep undrained depressions, the sharp topographical features in the drift, and the recent cutting down of clay flats. Effects of glacial action are well in evidence, since moraines, eskers, kames, outwash plains and kettle lakes occur over large portions.

The continental divide, separating the waters of the great lakes from those of Hudson bay, runs in a sinuous course through the region, but nowhere is it conspicuous as a ridge. Near Paska, kettle lakes occur in morainic sand deposits which form the divide. A boss of granite three miles wide occurs at the divide, altitude 1,118 feet, at Redmond. A large swamp with streams emerging from either side often forms the water shed. Towards the northwest of the map-sheet is Summit lake, a shallow muddy lake three miles long by a mile wide, which discharges water both ways. The Pawitik river flowing northward towards the Albany, carries probably a larger volume of water than the Ombabika, the southern

outlet, which is shallow and almost choked with wild rice. It seems probable that the Pawitik river channel will cut still deeper and close the southern outlet of Summit lake; thus the waters from Marshall and Summit lakes may finally flow northward, in which case the Ombabika river would have its source in the large swamp between Summit and Cross lakes.

O'Sullivan lake, looking southwest towards the inlet of Kowkash river.

Frank lake, looking southwest from the island near the centre of the lake.

The average magnetic declination for the area embraced by Map 26a is 1° west of north. Where the iron formation is extensive the local attraction may vary considerably. Along the meridian forming the east boundary of the Nipigon

Forest Reserve, the average declination at the time of survey in 1916 was found to be 0° 15′ west.

Canoe Routes

Two good canoe routes cross the map-sheet in going from Lake Nipigon to the Albany river and thence to James bay. One of these is the old route via the Ombabika river, Summit lake, Pawitik and Kapikotongwa rivers. Revillon Freres use this route in carrying supplies from Ombabika station to their fur post at Fort Hope on the Albany. The other route from Lake Nipigon is via the Onaman river to the height of land at Paska and down Johnson creek, Kawashkagama river, O'Sullivan lake and Little Current river, which joins the Kenogami within ten miles of the " Forks " on the Albany.

Since many of the lakes of the area have been previously described by earlier explorers, only a few notes will be given on the newly mapped lakes. The shores of O'Sullivan lake are generally low and rocky, thus differing from Abamasagi lake, which is almost lacking in rock, and is characterized by its boulder shores and large scattered white granite boulders standing out of the shallow water. The Kawashkagama river enters Abamasagi lake from the south and within a short distance turns round, as the Indian name implies, and flows southward again for a short distance. A large creek from the southwest enters the west bay of Abamasagi lake. About 15 chains up this creek a portage three-quarters of a mile long leads into Lower Meta lake, which is quite similar in size and shape to Abamasagi lake. The lake is also shallow, and has low boulder shores with little rock exposed, some of the bays being muddy and weedy. It is reported that a large river, a branch of the Kapikotongwa, flows out of the northeast arm. The narrows to the northwest open into Upper Meta lake, which was described by an Indian to be a large lake 30 miles in length and having a northeast and southwest direction, which would make it the largest lake in the area. About three-quarters of a mile up a small creek entering the southwest bay of Lower Meta lake is a portage one and a half miles long running in a southerly direction into Marshall lake.

Forest

The trees are mostly second growth, and consist of small spruce, poplar, balm of gilead, jackpine, balsam, white birch, cedar and tamarac, usually up to 8 or 10 inches in diameter, and occasionally attaining a diameter of 2 feet or more along parts of certain rivers and lakes. Scrub ash occur on the shores of many lakes. Large portions of these forests are suitable for pulpwood, and locally for ties, posts, mining and small timber. However, much of the forest along the railway and for several miles inland in places has been completely destroyed by fires, many of which probably occurred during the time of the construction of the railway. Because of these fires the amount of timber and pulpwood determined by the timber estimators in 1900 has been considerably reduced. Charred stubs and pieces of burned wood under the moss are relics of old fires. The best timber seen occurs on the portage between Marshall and Meta lakes. In this locality there are numerous spruce, jackpine, poplar and birch 18 and 24 inches in diameter. The only forest fires in 1916 were in the vicinity of Howard falls and on Eskegenaga lake.

The central figure is Robert Wells, discoverer of the Wells claim near Tashota.

Photo by W. J. Wilson.

Speckled trout 16 to 20 inches long: Albany river waters, Kowkash region.

Agriculture

The area is not promising for agriculture, since it lies to the west of the great northern Ontario clay belt, and is largely occupied by compact rock, sand, gravel, swamp and some stratified clay. Small isolated tracts of clay loam suitable for farming occur along Johnson creek, Ombabika river, Pawitik river and other parts of the area. In 1916 potatoes, beets, carrots, turnips, lettuce, onions and radishes were successfully grown by prospectors at mileage 60 on the railway and at the crossing of Johnson creek and the railway. Also, during the same summer, attempts were made by squatters to cultivate the good clay loam along Johnson creek which, in 1906, was denuded of trees by fires. Small trees have since come up, but these are easily cleared. Such land is excellent for farming purposes, but limited in extent.

Among the small fruits blueberries are very plentiful on the sand plains and rocky knolls, wild strawberries are found on the clay flats, while wild red raspberries grow everywhere along the sides of the railway.

Fish and Game

The larger animals consist of moose, caribou, red deer and black bears. Moose are very plentiful, while red deer are rather scarce. Wolves and lynx are numerous in certain localities. Foxes, including the red, black and cross varieties, and the smaller fur-bearing animals, viz.: beaver, otter, martin, fisher, muskrat, mink, weasel and skunk, are trapped in varying quantities. The beaver appear to have been plentiful about ten years ago, but are now nearly extinct. The only fresh beaver cuttings were noted on Wheatley lake and Phillips lake, which are secluded inland lakes away from the main canoe routes. Other small animals are the common squirrel, flying squirrel, chipmunk, rabbit, ground hog and porcupine.

Among the game birds are the partridge, prairie chicken, wild ducks and geese. In the autumn the wild ducks and geese gather in hundreds on Summit lake and the adjoining streams which are filled with wild rice beds. Loons, gulls, grebes and numerous song birds were seen.

The lakes and streams abound in fish. The waters contain pike and suckers in large numbers, and pickerel, whitefish, lake trout, perch and brook trout to a lesser extent. Four-pound whitefish are abundant in Marshall lake, and are known to occur in Abamasagi, O'Sullivan and Metcalfe lakes. Lake trout can be caught in Cross lake; a perch was caught in Jackson lake. Speckled trout are abundant, especially at Howard falls and other rapids on the Kawashkagama river and Wilgar creek. At times they can be caught freely with either fly or bait, averaging one foot in length. Several which were caught at Howard falls were 24 inches in length.

Water Powers

On the rivers are many small undeveloped water powers, the location and fall in each case being shown on the accompanying map. From some of these falls might be developed sufficient power for local mining development work. The best are on the Kawashkagama, the largest river. Rupert falls on this river has a

[illegible] feet in a distance of 240 yards. Howard falls, farther down the river, has a drop of 20 feet, due to a hornblende-chlorite ridge through which the river cuts, making a narrow canyon-like gorge 310 yards long. About four and a half

Indian on the Kowkash river taking pickerel from a net.

Photo by W. J. Wilson.

Howard falls, Kowkash river.

miles below the latter is Albert falls, with a drop of 11 feet in 50 yards. A series of rapids and falls with a natural head of 17 feet occurs in a distance of 330 yards on the Robinson river, about half a mile below the junction with Frank creek.

III. GENERAL GEOLOGY

The compact rocks are all pre-Cambrian. They have been glaciated, and are now thinly covered in places with Pleistocene deposits, and are classified according to the following table, the oldest rocks being placed at the bottom and the others arranged in the order of their relative ages.

LEGEND

PLEISTOCENE............. Boulder clay, sand, gravel, swamp, peat bogs, etc.

PRE-CAMBRIAN
KEWEENAWAN (?)........ Quartz diabase and gabbro dikes and sill remnants.

Intrusive Contact

TIMISKAMIAN (?)........ Schistose conglomerate, slate and greywacké.

Unconformity

LAURENTIAN (?)........ Quartz porphyry dikes.[2]
Granite,[2] rusty granite gneiss and pegmatite.

Intrusive Contact

KEEWATIN .... Serpentine.
Iron formation.
Rhyolitic tuff, agglomerate slate and conglomerate (?).
Rhyolite and quartz porphyry.
Basic pillow lava and diabase,[4] chlorite and hornblende schist and ferruginous carbonate.

MARSHALL LAKE SERIES.. Massive and schistose whitish quartzose rock with mica, hornblende, chlorite, garnet and staurolite, with some Iron formation and breccia.

Keewatin

The Keewatin rocks have a wide distribution, and are important since they contain gold-bearing veins. The rocks consist dominantly of basalt and rhyolite. Accompanying the latter are considerable volumes of agglomerate and fine black tuffs, associated with which are narrow bands of Iron formation. These rocks were probably deposited in the same water basin, and in some cases are interbedded. They are now greatly altered, and in places very schistose and closely folded. The rocks generally have a vertical dip, but the strike, which varies considerably, usually approaches the east and west direction.

The rocks are classed with the Keewatin, because they are similar to the Keewatin in other parts of Ontario and are probably the oldest rocks in the area. A more detailed description of the various types follows.

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[2] Some of these granites and quartz-porphyries may be Algoman in age.

[3] The serpentine on the Kawashkagama river lies in a position suggesting that it may be intrusive into the chlorite, hornblende and mica schists. It may be post-Keewatin in age.

[4] The basic extrusives at Cross lake contain mica schists similar to the Marshall Lake series, which can be separated on more detailed mapping.

Basic Extrusives, Etc.

The basic extrusives or greenstones, which are the oldest of the Keewatin, have the same general characteristics as the Keewatin basic rocks in Porcupine and other parts of Ontario. They consist of fine-grained altered basalt and dacite (?), which can usually be recognized by the ellipsoidal and amygdaloidal structure, and are roughly interbanded at times with a coarser, non-pillow, altered quartz-diabase. It seems certain that they represent successive flows which were poured out in the bottom of a water basin. Since their deposition the rocks have been turned up on end, and in places have become very schistose and entirely altered. The

Keewatin conglomerate? 15 chains southwest of mileage 45 on the railway.

Keewatin banded ash rocks and tuffs, mileage 51 on the railway.

original tops and bottoms of the flows have not been worked out. Some of the coarser varieties may be intrusives.

Generally, microscopic examinations do not give any clue whatever to the original nature of the rocks, on account of the intense alterations which they have undergone. However, a completely altered lava schist will sometimes retain the ellipsoidal structure on the weathered surface, showing the extrusive character of the rock. A massive pillow lava from a point half a mile south of mileage 41 on the railway showed under the microscope a network of albite laths in a groundmass consisting largely of calcite with small amounts of chlorite, leucoxene and iron oxide. All of the minerals in this rock including the feldspar, are secondary.

In the fresher samples of pillow lava a basaltic texture can be observed, showing rods of plagioclase set in a groundmass of pyroxene or hornblende, with much chlorite, calcite and other secondary minerals. The massive greenstones with non-pillow structure resemble in many cases altered quartz-diabases with the feldspars altering to saussurite. Much secondary calcite is generally present.

From these rocks chlorite and hornblende schists have been developed, associated with which are small amounts of agglomerate and tuff. Some of the chlorite schists may be altered tuffs. A prominent band of chlorite, hornblende slaty rocks extends along the north shore of O'Sullivan lake and the Kawashkagama river above O'Sullivan lake. The band lies between the typical pillow lavas and Laurentian (?) granite and rusty gneisses, and in places has a sedimentary appearance. At the west end of Cross lake the talc schist may represent an altered peridotite. Associated with the greenstone around Cross lake are some mica quartzose schists resembling the Marshall lake series which is described later in the report. These rocks could be further separated from the Keewatin at Cross lake with more detailed mapping.

Ferruginous Carbonates

These carbonates are not so prevalent here as in Porcupine and in many other parts of northern Ontario. The locations of the outcrops are marked on the map. A small exposure of silicious rusty dolomite may be seen at the northern end of the Tashota gravel pit. Its association with Iron formation suggests that it may have been a chemical sediment deposited with the iron. Narrow veins of ankerite were also seen on the Wells claim, and immediately north of the granite mass at the Tashota water tank. The various carbonates disseminated through many of the old rocks may represent replacement or decomposition products. The rock marked "ankerite" on the east shore of O'Sullivan lake gave on analysis: 12.12 per cent. of ferrous carbonate, 51.62 per cent. of calcium carbonate, and 22.07 per cent. of magnesium carbonate, the impurities being largely silica. The large peninsula on O'Sullivan lake, one mile and three-quarters south of the mouth of the Kawashkagama river, consists of rusty ferruginous bands interbanded with chlorite schist or pillow lava. Generally narrow quartz veinlets intersect the dolomite, but are not known to carry gold.

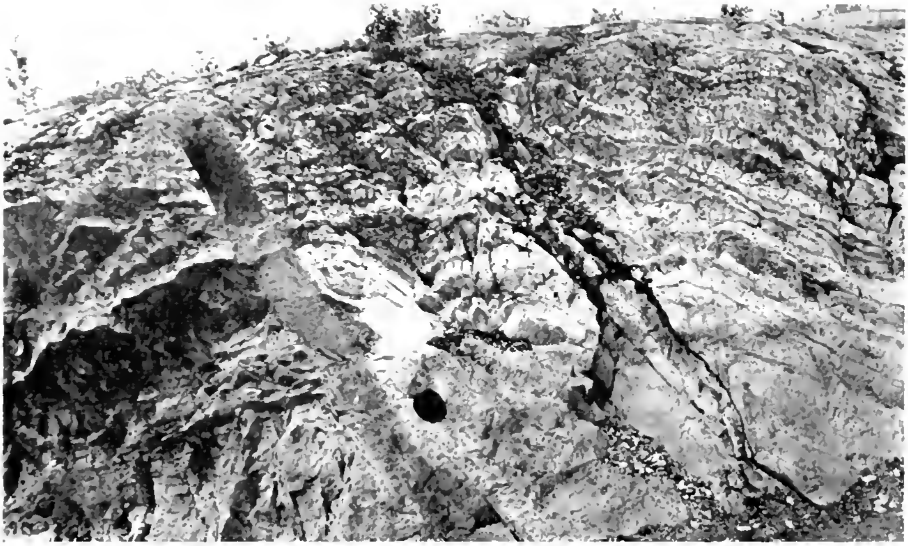
Rhyolite and Quartz-Porphyry

These white-weathering rocks are similar to the rhyolite porphyries at Porcupine, but have a wider distribution. They occur as irregular flow-like masses, often several miles in extent, with the greenstones in the south central part of the area. They are sometimes interbedded with the basic flows; occasionally the dike-like forms extend into the greenstones, but rarely into the black slates and iron formation. They pass into and are overlain by agglomerate, rhyolitic tuff, black slate and Iron formation, and are cut by granite, granite-porphyry and quartz-diabase.

The coarse rhyolites contain numerous white quartz phenocrysts, the size of beans, and some feldspar crystals in a glassy, light gray groundmass. These grade into a dark gray porphyry resembling chert. An exposure of typical white

massive rhyolite may be seen one-quarter of a mile northeast of Paska station, while a massive cherty variety occurs at mileage 50½ on the railway. The cherty nature may be due to some chemical change when the material was being laid down. The rock is generally schistose and sometimes brecciated. The white and grayish rhyolites in the vicinity of Metcalfe lake have been altered to sericite schist, soapy to the touch. They contain much disseminated pyrite, have a rusty weathering surface, and are cut by quartz veinlets which contain some bismuthinite. No feldspar phenocrysts were noticed in this particular rhyolite.

E. S. Moore, who examined numerous thin sections of rhyolite-porphyries from the Onaman Iron range, describes their microscopic characters as follows:—



Banded Keewatin ash rocks cut by narrow lamprophyre dike, mileage 50.6, railway

These rocks all have a porphyritic texture and a holo-crystalline groundmass, the latter developed by re-crystallization under metamorphic agencies. The groundmass is usually crypto-crystalline, but varies in some cases to micro-crystalline. In almost all cases the phenocrysts have been broken during the metamorphic processes, and the cracks filled with sericite or calcite, or both. In some of the rhyolites the crystals have been pulled apart and the spaces between the fragments filled with the regular groundmass, in such a way as to indicate that this process took place during the extrusion and movement of the molten rock. The proportion of quartz, orthoclase and plagioclase phenocrysts varies greatly. In some slides no quartz crystals occur, in some plagioclase and orthoclase are nearly equal, and in others all three may be well represented. The quartz phenocrysts sometimes contain mineral inclusions. The phenocrysts of both quartz and feldspar are very often rounded or gouged by the groundmass.[5]

Rhyolite-tuff, Agglomerate Slate and Conglomerate (?)

The rhyolite flows appear to pass gradually into pyroclastics and sedimentary rocks consisting of rhyolite-tuff, agglomerate slate and conglomerate (?), with no sharp line between them. Along the railway from mileage 55 to 51 one can see a gradual transition from rhyolite to agglomerate, which changes to ash rocks and finally to bedded greywackés. Numerous small outcrops occur in the Onaman Iron range. The most prominent band of the volcanic fragmental rocks extends

Report, Ont. Bur. Mines, Vol. XVIII, 1909, p. 224.

from a point one mile south of Kowkash station in a northwesterly direction for 11 miles to Growski lake, where it is intruded by the granite. The railway follows this narrow band of soft rocks for several miles; 15 chains southwest of mileage 15 on the railway is a large isolated outcrop which resembles conglomerate. The pebbles consist dominantly of cherty rhyolite with an occasional quartz pebble. No greenstone pebbles were noticed. The fragments vary from microscopic size to over three feet in length. Many are rounded and water-worn, while others are angular. The groundmass has the appearance of rhyolite and occasionally of greywacké. The fine ash rocks were probably deposited in water, since they are usually stratified, and resemble slate and greywacke or arkose which now stand on end. They are cut by narrow mica-lamprophyre dikes, granite, granite-porphyry and quartz-diabase. The mica-lamprophyre dikes may be of Keewatin or later age.

Tourmaline occurs in the rhyolite and other closely associated rocks, viz.: slates, greywackés, matrix of the conglomerate and Iron formation. Moore suggests that the tourmaline is the result of fumarole action, occurring as the after effects of the acid magma which formed the rhyolites and rhyolite porphyries. Tourmaline also occurs in quartz veins cutting these various rocks, and in the auriferous quartz veins in the Keewatin at Tashota.

Iron Formation

The Iron formation is composed largely of red jasper, some "sugary" quartz, often well banded, and magnetite with a little specular hematite lying conformably upon the pyroclastic and sedimentary rocks previously described. It occurs largely as outcrops arranged in two bands running east and west in the vicinity of Johnson creek. The northern range outcrops run from Nixon lake easterly for ten miles to a point two miles to the south of Kowkash. The southern range, locally known as the Bain deposit, two miles to the south, extends from Castor lake easterly for two miles, and approaches 700 feet in width, but contains much foreign rock.

Shortly after the discovery of the iron ranges in 1906 numerous claims were staked by the Flaherty syndicate, C. Bain and other prospectors. Much stripping and trenching and some diamond-drilling were done, but finally the ranges were vacated and the claims allowed to lapse. E. S. Moore identified the mineral dumortierite ($Al_{20}Si_7O_{44}$) in the jasper and slate of this area. The origin of the iron deposits is accounted for by Moore as follows:—

> From a consideration of the different theories for the origin of these deposits, the writer concludes that the original rocks were cherty iron carbonate and oxide. The materials were supplied to enclosed basins by weathering action under the influence of plant life, and by heated igneous rocks coming in contact with the waters. These rocks supplied salts of iron and the alkalies to the waters. That cherty iron carbonate was the original rock which gave rise to much of the magnetite and hematite is evident from the wide distribution of this mineral in all the iron formation rocks, and by the transitions between it and magnetite which may be seen in the thin section. That part of the hematite has been deposited as limonite, and dehydrated, is suggested by its very close resemblance to some of our bog deposits of the present day. Under the microscope one can see the gradations from a clastic slate with some iron oxide, into a mixture of hematite and minor amounts of mechanical sediment. The composition and texture of the rock are just what one would expect if some of our bog ores were highly metamorphosed. Since the deposition of these rocks they have been subject to extensive metamorphic changes which have developed magnetites and hematites from the carbonates, and crystallized silica from the chert.[5]

[5] Rep. Ont. Bur. Mines, Vol. XVIII, 1909, p. 243.

Other narrow bands of magnetite and chert occur to the southeast of Redmond near Lake St. Marie and in the vicinity of Tashota. At Lake St. Marie and other places the magnetite has been almost wholly replaced by pyrite which carries low gold values. On the Cline claim near Tashota the narrow iron formation band is partly replaced by pyrite and cut by quartz veinlets which carry visible gold.

Serpentine

An area of massive, rather hard serpentine occurs for three miles along the Kawashkagama river immediately above O'Sullivan lake. Its relationship to the other rocks is not known, but it lies in a position suggesting that it may be intrusive into the Keewatin mica-hornblende-chlorite schists.

Under the microscope the serpentine is clearly seen to be altered from crystals having olivine outlines. There are present in the thin section large areas of calcite and numerous grains of magnetite. At the last portage before reaching O'Sullivan lake, and near the edge of the outcrop, the rock becomes very schistose and resembles slate. Under the microscope the rock of this portage is seen to be composed almost entirely of actinolite in broad plates and fibrous aggregates.

On analysis a sample of the serpentine showed the following composition:—

Silica, 37.54; Alumina, 6.36; Ferric Oxide, 5.00; Ferrous Oxide, 6.91; Lime, 2.55; Magnesia, 28.66; Soda, 0.70; Potash, Trace; Chromium, Trace; Carbon Dioxide, 3.06; Water (combined), 9.44; Total, 100.22.

The only other serpentine rock seen occurs on the southwest shore of Cross lake. Numerous small veinlets of asbestos and magnetite run indiscriminately across the serpentine, which has distinct olivine outlines and is probably an altered peridotite. The metallic veinlets do not contain any chromium. The talc schist in this vicinity may represent another alteration phase of a peridotite.

Marshall Lake Series

Marshall Lake series is the name here proposed for a group of metamorphic, quartzose rocks occurring in large volume in the vicinity of Marshall lake. W. A. Parks in his report on the area classes these rocks as Huronian (Keewatin) and he groups the light-coloured type (Marshall Lake series) and the Keewatin greenstones in one class. A. W. G. Wilson followed Mr. Parks, and classed them all as Keewatin on his map of Lake Nipigon; however, in his accompanying report he states that the acid schistose rocks in the Summit and Marshall lake region occupy a very doubtful position between undoubtedly Keewatin and undoubtedly Laurentian. On map No. 864 published by W. J. Wilson and W. H. Collins in 1914, of the Canadian Geological Survey, the same rocks are mapped as Laurentian. This group of rocks which is, therefore, of doubtful age is here called, for convenience, the Marshall lake series, and will be more fully described.

The Marshall lake series occurs in one large area extending from Marshall lake along the Lily river and lake and southward along the east boundary of the Nipigon Forest Reserve to Willet and Albert lakes. In the vicinity of the latter lake some Keewatin rocks may be included with the series. Rocks, similar both megascopically and microscopically, occur also in small volumes with the pillow

lavas on Cross lake and with the diorites and amphibolites on the long portage westward from Cross lake. However, considerable detailed work would be required to map all these rocks separately. The series, as far as known, covers roughly about 75 square miles. The rusty garnetiferous schists on Pawitik river and the north shore of O'Sullivan lake may also belong to this series.

The series is made up of fine-grained metamorphic rocks consisting dominantly of whitish quartzose-mica-schists, alternating with subordinate amounts of hornblende-garnet and staurolite-quartz-schists, and rarely with iron formation. The light-coloured, quartzose-mica-schist contains large, angular, broken fragments of white and bluish quartz set in a finer groundmass of quartz, with considerable mica and other secondary minerals. A sample from the 83 mile post on the Nipigon Forest Reserve boundary was examined microscopically and found to consist largely of quartz and biotite in a ratio of four to one, the biotite being partly altered to chlorite. Some calcite and magnetite and a few garnet masses are present. Such rocks are probably clastics, associated with which are small amounts of similar-looking rocks which when examined microscopically proved to be igneous in character. One such sample from the big island on Lily lake showed a large altered feldspar phenocryst in a fine groundmass of quartz with biotite and hornblende altered partly to chlorite. Some calcite, magnetite and apatite were also present. Seven samples of the whitish quartzose-mica-schist taken from various places in the vicinity of Lily lake were analysed as one composite sample by W. K. McNeill. The results were as follows: Silica, 59.10; Ferric Oxide, 1.15; Ferrous Oxide, 2.16; Alumina, 23.03; Lime, 1.40; Magnesia, 1.30; Soda, 3.82; Potash, 2.30; Carbon Dioxide, 0.57, and Water 1.97 per cent. This analysis resembles closely the analysis given by A. C. Lawson for the Couchiching of Rainy lake.

W. A. Parks collected a rock of the quartzose-hornblende type from a locality near the western end of Lily lake and describes it as follows:—

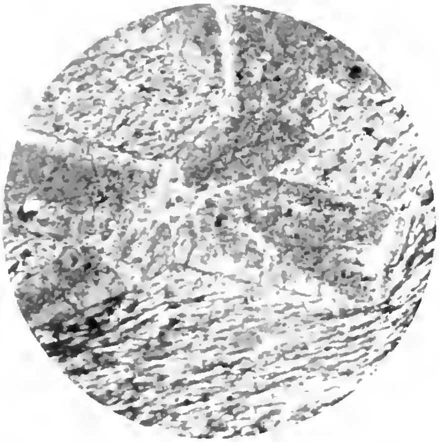
> Under the microscope this rock shows a fine mosaic of quartz fragments, all much torn and broken. Larger corroded pieces of hornblende occur, in part altered to chlorite, and other secondary minerals. Grains of pyrite and of magnetite are common, as well as bars and needles of apatite. The whole rock shows evidence of much alteration, so that its original nature is doubtful, but from the occasional occurrence of larger fragments of quartz with distinctly broken borders, the rock would seem to be a clastic.

Associated with these rocks are narrow bands of somewhat similar rocks, which contain in addition numerous red garnets and staurolites occurring as wart-like protuberances upon the weathered surface. A garnetiferous quartz mica schist from a point about three-quarters of a mile east of mileage 84 on the Nipigon Forest Reserve line shows large masses of altered garnets, with quartz and calcite in a fine granular groundmass consisting of 60 per cent. quartz, 30 per cent. biotite, largely altered to chlorite, and small amounts of calcite, magnetite and pyrite. On the northwest shore of Albert lake can be seen a dark-coloured medium-grained rock containing beautiful large staurolite crystals. Under the microscope the staurolites are often twinned, and around these crystals bend numerous biotite flakes which are partly altered to chlorite and epidote. Much quartz and small garnet masses also occur in the groundmass. These particular bands of rock

contained, originally, certain minerals which yielded garnets and staurolite after metamorphism.

On the south central shore of Marshall lake, and immediately north of the east end of Willet lake, are narrow bands of Iron formation consisting of "sugary" quartz, chert, slate and rather thin layers of magnetite, associated with which are considerable amounts of pyrrhotite and pyrite. These bands appear to be a part of the Marshall lake series. The hornblende biotite schists on the Kowkash river between O'Sullivan and Abamasagi lakes and also on the north shore of O'Sullivan lake, may belong to the Marshall lake series.

This series resembles somewhat Lawson's Couchiching rocks of Rainy lake. It is also apparently similar to the mica-hornblende-quartzose schists occurring at the edge of the Keewatin area in the vicinity of Long lake, which are described



Photomicrograph of a staurolite-garnet mica schist from Albert lake, showing a large twinned crystal of staurolite around which bend the flakes of biotite. Magnification 20.

as Keewatin elsewhere in this volume by A. G. Burrows. In addition it resembles a part of the Grenville in southeastern Ontario, and M. E. Wilson's Pontiac series in western Quebec.

The chemical composition, microscopic evidence and frequent occurrence of alternating coarse and fine bands in these quartzose rocks suggest that they are clastics or volcanic fragmental rocks deposited in water. Since they are interbanded with ellipsoidal lavas on Cross lake and contain some iron formation, they are apparently closely associated with the Keewatin. However, the contact on an island half a mile from the east end of Willet lake appears to show the Keewatin amphibolite or altered diabase cutting the white quartzose rock of the Marshall lake series. The acid, igneous rocks of the series may be Laurentian, but it would be impossible to separate the igneous from the sedimentary type. The series is cut by Keweenawan quartz diabase and an occasional pegmatite dike, but was not seen in contact with the granite.

Laurentian (?)

About one-half of the area is represented by acid rocks, viz.: granite, granite-gneiss and pegmatite, etc., which occur in the form of batholiths, bosses and dikes. They are grouped together since they can be separated only in places and with difficulty. They are classed Laurentian (?) because the granite-gneiss and pegmatites are similar to the Laurentian in other parts of the pre-Cambrian shield; however, the fresher massive granites resemble the Algoman in Cobalt, Porcupine and Kirkland lake.

Gneisses

The granite-gneisses are not nearly so prevalent as the massive granites. The main occurrences are marked on the map and may be called granite-gneiss containing biotite, hornblende or both these minerals. They grade into massive granite in the vicinity of Frank lake, Ombabika station and other places. The rusty-weathering garnetiferous mica schists on the Pawitik river and Meta lake, although mapped with the Marshall lake series, may be Laurentian.

Granite hill on the south shore of Cross lake, probably 300 feet high.

Granites

The granites have a much wider distribution than the gneisses and, in many cases, are younger. On the northeast part of O'Sullivan lake the granites were seen cutting the gneiss, and on the west side of the narrows of Jackson lake, and on the west shore of Goode lake, the granite contains inclusions of an older-looking gneiss. The massive, fresh-looking varieties resemble the Algoman granites in other parts of Ontario. They are red or gray in colour, and of the biotite and hornblende type. Often the granite is porphyritic, with orthoclase crystals one inch in length, as on the portage below Goode lake. The granite may grade into a hornblende syenite, as on the southwest shore of Gzowski lake. The granite is cut by quartz veins and by pegmatite, aplite and other dikes representing differentiation facies of the magma. Also some of the darker facies to the south of Ta-hota station and west of Ta-hota creek, may be due to the assimilation of the adjacent schist complex. The homogeneous red granite mass at Redmond contains microcline showing the gridiron structure, albite, quartz and biotite partly altered to chlorite.

The stock-like granite mass at the Tashota water tank clearly sends tongues into the adjacent Keewatin rocks, and a hornblende syenite dike can be seen cutting the rhyolites at mileage 56.3 on the railway. The granites at mileage 73 and 74 on the railway are massive and jointed, and appear to be of a quality suitable for building stone.

Quartz Porphyry

Numerous narrow dikes of quartz-porphyry occur in the vicinity of Tashota and Howard falls, while an occasional dike may be seen over scattered parts of the entire area. They probably represent apophyses from the granite masses and hence are Algoman in age. The fact that the porphyry usually occurs near the gold-bearing quartz veins, suggests a relationship between the intrusive and the veins, and hence their importance.

The porphyry occurs as dikes up to 30 feet in width. The white-weathering surfaces make them stand out conspicuously in the dark greenstones. The porphyry contains numerous white quartz phenocrysts, the size of peas, and some feldspar phenocrysts in a fine-grained, grayish-white groundmass. The porphyry also contains some quartz stringers, is schistose in places and resembles the quartz-porphyry in other parts of the Province. A sample from the Dodds claim which was examined microscopically showed large, rounded, angular and broken quartz grains, and albite phenocrysts, partly altered to sericite. The crystalline groundmass consists of quartz, feldspar, sericite, calcite and a little chlorite. This description will also answer for the porphyry from the Wells claim.

Timiskamian (?)

Two small exposures of conglomerate slate and greywacké apparently similar to the Timiskamian sediments in Porcupine and Kirkland lake, occur in two widely separated parts of the area, viz.: two miles below Howard falls on the Kawashkagama river, and on the northeast arm of Cross lake.

Sediments on Kawashkagama River

The bedding and schistosity of the sediments below Howard falls strike 65° and have a vertical dip. On the south part of the exposure there is a slate band 50 feet wide, north of which is a conglomerate band 100 feet in width and containing a great variety of pebbles, elliptical in shape. They consist of rusty mica-granite gneiss similar to the Laurentian (?) rusty gneiss on the northeast part of O'Sullivan lake, quartz-porphyry or rhyolite, chert, and amygdaloidal basalt. The nature of the conglomerate would suggest an unconformity between it and the underlying Laurentian (?) and Keewatin. The conglomerate is separated, on the north, by a few feet of drift from a large volume of massive pillow lava.

Sediments on Cross Lake

A narrow fringe of sediment skirts the irregular south shore of the northeast arm of Cross lake. The sediments consist dominantly of conglomerate with some greywacké and slate. The strike is southeasterly, and the dip almost vertical. The conglomerate is a typical beach conglomerate, containing numerous coarse pebbles

about four inches in length with little matrix. The pebbles consist chiefly of gray feldspar-porphyry and a gray quartzose mica rock resembling the Marshall lake series, with an occasional greenstone and white vein quartz pebble. A thin section

Porphyry dike in Keewatin green schist.

Timiskamian (?) conglomerate, Cross lake.

of one of the gray porphyry pebbles showed microcline, albite, and a few quartz phenocrysts in a microcrystalline groundmass of quartz, biotite partly decomposed to chloritе, and iron oxide.

Keweenawan (?)

The quartz-diabase, of which the gabbro is a phase, penetrates all the other rocks. It is classed as Keweenawan since it is similar to the Keweenawan olivine-free type of diabase which occurs in large volume around Lake Nipigon, a few miles to the west, and in other parts of Ontario. The dikes, which are usually vertical, vary from a few inches to 200 feet in width, and can be traced for over a mile on the surface. A small remnant of a sill lying nearly horizontal occurs near mileage 56 on the railway. The outcrop half a mile northeast of Howard falls is a stock-like mass of coarse diabase showing the ophitic structure. A thin section of a typical quartz-diabase from a dike on the Lily river two miles east of Lily lake consists of labradorite laths showing albite twinning lamellae partly altered to saussurite, augite partly decomposed to hornblende and epidote, and beautiful graphic intergrowths of quartz and feldspar. The finer minerals

Keweenawan quartz diabase dike (black) cutting granite, mileage 70.5, railway.

consist of quartz, biotite partly altered to chlorite, magnetite or ilmenite, a little calcite, and apatite needles. No olivine was seen in the thin sections that were examined. Pyrite and pyrrhotite are present in many of the diabases.

Pleistocene Deposits

The map-area lies near the western edge of the northern Ontario clay belt, whose clays were probably deposited in Lake Ojibway. There is some doubt as to whether this particular area was covered by Lake Warren, or Lake Ojibway, or parts of each.

The recent drift deposits consist of stratified clay, boulder clay, sand, gravel, boulders, swamp, moss litter and peat bogs, many of the areas being outlined on the map. Most of the swamps are underlain by peat bogs, some over six feet in thickness, along many parts of the railway. Underneath the peat in places is

stratified clay, as on parts of Cross lake. The stratified clay occurs in isolated low areas, while the sand and gravel usually occur in prominent ridges. When the clay is mixed with some glacial sand, as along parts of Johnson creek, a good clay loam, suitable for agriculture, is formed.

Extensive terminal morainic hills, from the height of land near Paska along Johnson creek to Cavell and eastward beyond the map-sheet, stand out prominently, having been completely denuded of vegetation by forest fires in 1906. These ridges mark the position held by the front of a glacier for a long period. The deposits are largely moraines, with kames and eskers less prominently developed. The stratified sand and gravel pit at Titania probably represents a kame, while Kowkash is built on an outwash plain formed from an ice-sheet. The numerous

Photo by E. S. Moore.

Kettle lakes in terminal moraines near Johnson creek, south of Kowkash station.

kettle lakes may be due to buried masses of ice melting out after the retreat of the main ice-sheet. Some of the depressions are now dry and the bottoms are as much as 80 feet below the tops of the hills surrounding the basin. As many as five of these lakes without visible outlets may be seen in one photograph. The deposits are made up of sand, gravel and coarse boulders composed of granite, greenstone, chert, fossiliferous limestone and other rocks, many of which, in the vicinity of Paska, are coated with white calcium carbonate. Although many of the pebbles may have travelled long distances, the greater number are similar to the local rocks. The nearest known Paleozoic limestone "in place" is the Silurian, which occurs about 55 miles to the northeast of Cavel station.

Where the soil has been removed the glacial scratches and grooves are often well preserved, the jaspers, especially, having retained their beautiful polish. The

ice moved from the northeast over the height of land in a general southwest direction, the directions of the striations varying from S. 30° W. to S. 50° W. On Obonukegan (Narrow) lake a prominent glacial groove has a southeast direction, while farther down the north branch of the Onaman river, opposite mileage 61, (Nipigon Forest Reserve), the direction is east and west. These variations may represent local differences in the ice movement.

The north branch of the Onaman river (near mileage 66, Nipigon Forest Reserve line) wearing its way through a flat, densely-wooded, boulder country.

A Recent Deposit: Travertine

Much fine calcium carbonate was seen coating the pebbles, roots and stems of plants in the upper three miles of the north branch of the Onaman river. Many small fresh-water shells also occur in these parts. E. S. Moore describes a deposit of calcium carbonate, or travertine, of considerable extent half a mile from Paska station and occurring in Red Paint lake, which is fed by springs issuing from the drift beneath, as follows:

The deposit of calcium carbonate, or travertine, in Red Paint lake, is at least 20 feet deep at the southeastern end, as a pole can be thrust down into it to that depth. Around other portions of the lake the deposit varies greatly in thickness, and may even be lacking.

> The creek leaving the lake is so saturated with calcium carbonate that it deposits tufa on the roots and stems of plants along its course, and on the bottoms of the upper lakes the Red Paint river. . . . The source of this mineral is probably the calcareous coating found on the pebbles of the drift in the surrounding region. . . . Were this deposit favourably situated, it might be used in the manufacture of cement, but there are no prospects so far as can be seen at the present time, of its becoming of economic value. Even the coming of the new railroad is not likely to awaken any industrial interest in a region so isolated and so far removed from the centres of population.[7]

Somewhat similar material occurs in Wawong and other small lakes to the north east. The water in Wawong lake, as the Indian name implies, is very clear and of a peculiar bluish-green colour. White shell marl was also seen in a small pond half a mile to the southwest of the Tashota gravel pit.

IV. ECONOMIC GEOLOGY

Gold: Character of the Deposits

Gold is the chief mineral sought for in the area at the present time. The gold-bearing quartz veins occur chiefly in the Keewatin pillow lava and diabase schist, and occasionally in the Iron formation, which have been intruded by quartz porphyry dikes probably of Algoman age. The chief gold deposits occur in the vicinity of Tashota and Howard falls, where the quartz porphyry intrusions are most pronounced. The veins vary from mere stringers to 8 or 10 feet in width, and have various strikes and dips. At times, there is an aggregate of minute stringers through which gold-bearing solutions have passed.

Examination of thin sections of the ore shows that the gold occurs along dark seams of crushed quartz, calcite, chlorite and pyrite. The gangue consists largely of fractured quartz with considerable calcite, chlorite and some biotite. Pyrrhotite and pyrite are abundant in the deposits, while tourmaline and chalcopyrite are present in several veins. The gold is usually found in contact with some of the sulphides. Numerous fine grains of native copper were seen near the surface of the Wells vein, and in other quartz veins immediately west of the Tashota gravel pit. Finely disseminated bismuthinite occurs in the Devanney deposit, and on the Knapp claim, which lies two miles south of the Tashota gravel pit, also in several narrow quartz stringers which cut the rusty rhyolite schist to the east of Metcalfe lake. Five quartz samples, some containing bismuthinite taken to the east of Metcalfe lake gave no values in gold. The Knapp veins in addition to bismuthinite contain some graphite or molybdenite. A gray mineral from the Devanney vein gave a reaction for tellurium. Fluorspar occurs finely disseminated in a vein near the crossing of the railway and Tashota creek, a sample from which gave no values in gold.

Origin of the Gold Deposits

In northeastern Ontario most of the gold deposits are believed to be of Algoman age. At Kowkash and Tashota the gold is found near the porphyry intrusives and, at times, the veins run from the porphyry into the adjoining schists, which would suggest a similar relationship between the veins and the intrusives. The

[7] Report Ont. Bur. Mines, Vol. XVIII, 1909, p. 252.

porphyries in this area, which are probably apophyses from the underlying granite masses, also resemble the Algoman rocks in other parts of the Province.

The cooling of these acidic rocks was probably accompanied by shrinkage and faulting in the porphyry and adjacent rocks. These fractures were then filled by gold-bearing solutions, which in all probability represented the end product of the porphyry intrusions. The veins have since been enlarged in places by replacement of the country rock.

Pyrrhotite, tourmaline, biotite and other minerals suggest that the veins were formed at a high temperature and pressure and at a great depth.

Description of Gold Claims

The various claims on which gold has been found, although not surveyed, are approximately located on the accompanying map for convenience, and may be described as follows:

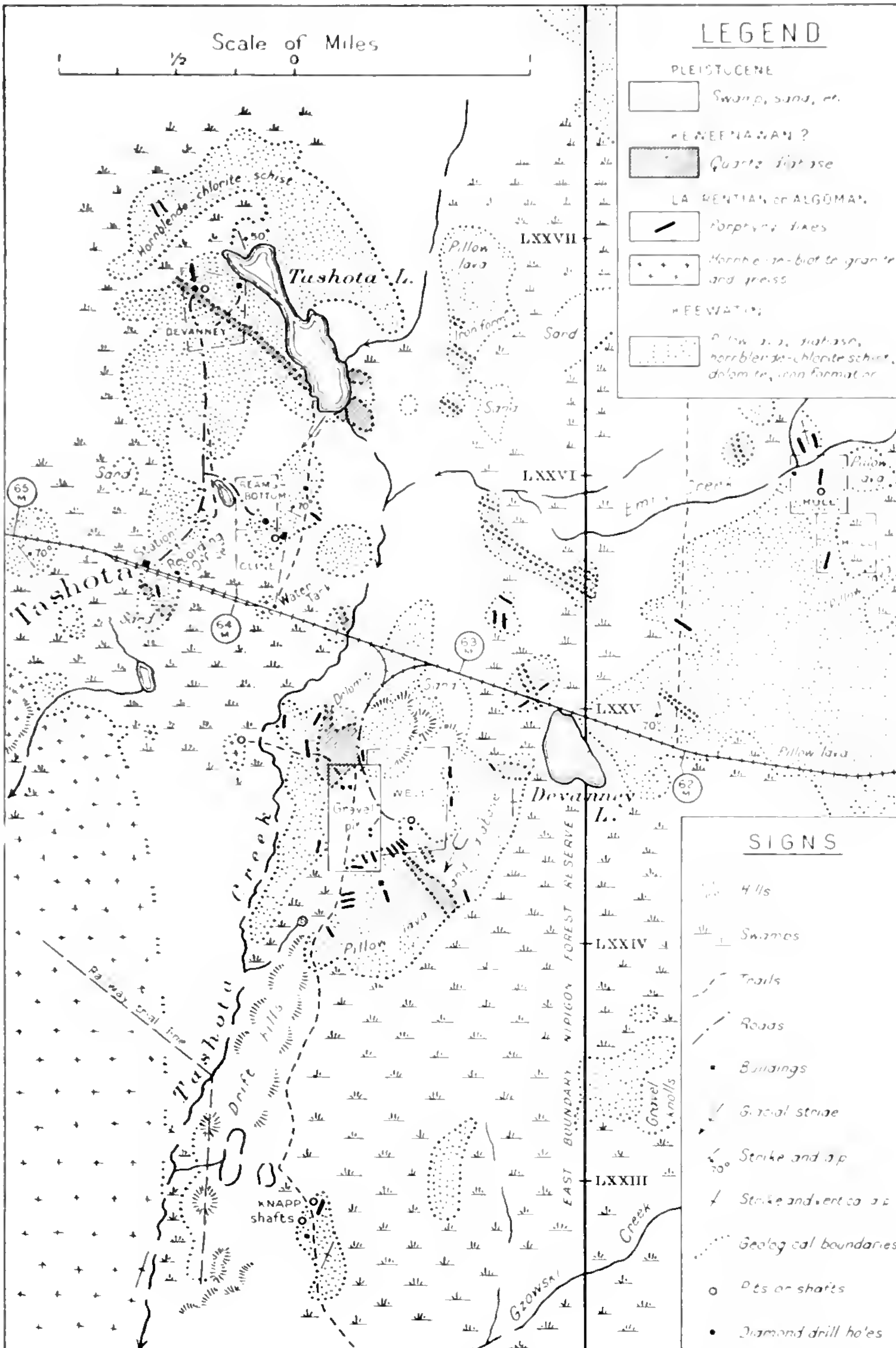
King-Dodds

The original gold find which caused the rush to the area was made on the King-Dodds claim T.B. 2121, about three-quarters of a mile east of Howard falls, on the Kawashkagama river. The quartz vein strikes 10° south of east and dips 75° to the north, thus conforming in strike and dip with the country rock. The wall rock is pillow lava (meta-basalt) altered in places to schist. Numerous quartz porphyry dikes, up to 30 feet wide, occur on the claim. The vein has been traced 100 feet on the surface, over which it will average three inches in width. The quartz is white, somewhat glassy in appearance and largely free from sulphides. An abundance of free gold occurred for four or five feet along the vein on the surface next the hanging wall. Lying along the north side of the quartz is a rusty schist band, six inches wide and heavily impregnated with iron pyrites.

The claim was optioned to T. B. Caldwell of Lanark and Messrs. Fraser and Orn, who did considerable stripping and sinking. In sinking, the showing of gold disappeared in about three feet. When work was suspended early in November, 1915, the shaft was 16 feet in depth, where the vein was two inches wide with a foot of pyritous schist, carrying low gold values, on the foot wall. Work was resumed again in November, 1916. At a depth of 40 feet considerable visible gold was again encountered, and favourable gold assays were obtained from other parts of the vein, which is lenticular, varying from a minute stringer to five or six inches in width. The schist adjoining the vein is well mineralized and carries gold values. During the summer the Tash-Orn Mines Limited, intended installing a small boiler, steam drill and pump. The shaft which is at present 56 feet deep, will be continued and drifting and cross-cutting done.

Richardson-Loudon-Ogilvie

During the first week in October, 1915, gold was found on Claim T.B. 2599, near the first rapids on the Kawashkagama river two miles below the junction of Johnson creek. The quartz vein is narrow, averaging about two inches in width over a length of 200 feet. The vein strikes south 85° east, and dips about 70° to the south. The rock is Keewatin pillow lava, and near the vein is a biotite



Plan showing the topography and geology in the vicinity of Tashota, N. T. C. railway. The Wells, Hull, Devanney, Cline and Reamsbottom claims are located approximately.

granite dike six feet wide. Coarse gold could be seen in six or seven places along the vein, and pyrite is also present. Rock outcrops in this vicinity are scarce, but further trenching may reveal larger auriferous quartz veins.

Devanney

In the autumn of 1915 a little visible gold and encouraging gold assays were obtained from the Devanney claim near Tashota, which is 22 miles west of Kowkash station. This resulted in much staking and other gold finds being made in the vicinity of Tashota.

The Devanney claim, T.B. 2650, lies about one mile and a quarter north of Tashota station on the northwest shore of Tashota lake. The main vein has a tortuous course along a general northwest and southeast direction, and dips from 50° to 80° to the southwest. The vein is lenticular, varying in width from a few inches to 8 feet and is traceable, intermittently, for about 1,000 feet. Adjacent to the vein, in places, are other narrow parallel veins. The white quartz has occasional narrow dark bands parallel to the walls, and resembles the "Rea" vein at Porcupine, described by A. G. Burrows in his report on that area. The dark seams consist of tourmaline, pyrrhotite, pyrite and crushed quartz. Certain parts of the vein comprise a mixture of schist and quartz, which are heavily impregnated with pyrrhotite, pyrite and tourmaline with smaller amounts of chalcopyrite, mica and chlorite. A very little visible gold, a telluride and bismuthinite are also present. The wall rock, a Keewatin greenstone, is entirely altered to chlorite, calcite and quartz, and is cut by narrow quartz porphyry dikes.

The property was under option to the Tash-Orn Mining Company which did considerable stripping, sinking of test pits and diamond drilling during the summer of 1916. Three diamond drill holes were put down in the vicinity of the 20-foot shaft to test the vein at vertical depths of approximately 100, 150 and 250 feet respectively. The vein where cut in each case was about eight feet wide, but the gold contents were reported to be low.

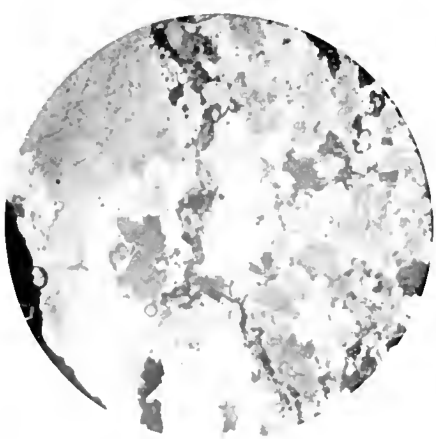
Wells

The Wells claim, T.B. 2892, is situated in the Nipigon Forest Reserve about one mile and a half southeast of Tashota station. Gold was discovered on this claim June 23rd, 1916, by Robert Wells of Tashota, who sold under option to the Tash-Orn Mines, Limited, for $25,000.

The rocks on the property are chiefly Keewatin pillow-lava schists, which have a general strike of 30° east of north and dip vertically. These are cut by narrow, altered quartz-porphyry dikes, probably of Algoman age.

A shaft was commenced on a lens of quartz, several feet in extent and carrying visible gold. Running north from this lens on the surface there are numerous parallel quartz stringers through which gold solutions have circulated. To the northwest of the shaft, small lenses of quartz can be traced for about 90 feet. The shaft was sunk vertically to a depth of 100 feet and visible gold, sometimes coarse in character, was encountered to this depth in various parts of the vein. A shipment of 700 lbs. of ore from the shaft at a depth of 30 to 35 feet was

General view of the Wells, June, 1917, one year after the discovery of gold on the claim. Looking east from the railway ballast pit; shaft house on the left.



Crossed Nicols.

With Polarizer.

Photomicrographs of a section of Wells ore showing secondary fracturing of the primary quartz, along which gold, calcite, pyrite and chlorite have been deposited. The black areas along the fracture are gold and pyrite. Magnification 20.

reported to give, on assay $20 of gold to the ton. At a depth of 92 feet drifts have been run to the north on the numerous parallel veins, and to the southwest following the irregular strikes of the lenses, and in addition some cross-cuts have been made. The vein is greatly brecciated, the gold generally occurring along the dark fractures, which are filled with crushed quartz, calcite, talc, chlorite and pyrite. Some native copper is present in the vein at the surface, while chalcopyrite, pyrrhotite, tourmaline and sericite occur in varying quantities. The deposit has been enlarged by the replacement of the country rock. The mineralized schists adjoining the veins and between the lenses sometimes carry gold values, but often they do not contain any gold. Some ore has been developed, the length of the shoot on the first level being longer than it is on the surface. The ore is reported to average $5.00 of gold to the ton. At present, June 12th, 1917, the shaft is 120 feet deep, and it is expected to be down 200 feet by July, 1917.

The property is equipped with a small plant including boiler, 2-drill compressor, hoist, cage, assay office, and necessary buildings for a force of 50 men. Fortunately for the company a siding of the National Transcontinental railway runs within a quarter of a mile of the property. M. Summerhayes of the Porcupine Crown mine is consulting engineer.

The Tash-Orn Mines, Limited, is capitalized at $3,000,000; the officers of the company are: Joseph Castelberg, president; John L. Orn, managing director.

Hull

Late in November, 1916, a discovery of visible gold was made on the Hull claim, K.K. 92, which is situated about two miles northeast of the Wells, or about a mile north of mileage 61 on the railway. Messrs. Kipper, Rivett and Goad are interested in the claim.

The rock is Keewatin pillow-lava schist, which has been intruded by a few gray quartz-porphyry dikes. The deposit consists of lenses of quartz and parallel quartz stringers traceable for a few hundred feet, and having a total width of three to eight or more feet. The vein system strikes a little west of north, thus coinciding with the strike of the country rock, and dips about 15° to the west. During the winter of 1916-17 an inclined shaft was sunk on the vein to a depth of 50 feet, but this was full of water at the time of the writer's visit. However, much visible gold was seen on the footwall side of the vein at the collar of the shaft, and considerable free gold was reported to have been encountered at various places, often in vugs, in sinking. Mr. Hull also reported that a chipped sample across five feet taken at a depth of 15 feet in the shaft assayed $28 of gold to the ton. Much pyrite and tourmaline are present, while chalcopyrite and pyrrhotite are less prominent. The gold usually occurs along dark seams in the quartz containing talc, sericite, chlorite, etc. A little native copper was found in the shaft near the surface.

A similar-looking deposit, and probably a continuation of the above, extends southerly across the adjoining Hull claim, K.K. 90. In the southwestern part of the claim, where the principal workings have been carried on, there are lenses and stringers of quartz in mineralized green schist at the contacts of a quartz-porphyry dike. Occasionally the veins extend into the porphyry. Visible gold

was found in this part, and gold colours can be panned from much of the quartz and mineralized schist.

At present, June, 1917, stripping, test-pitting and sampling are being carried on.

Hendrickson

The Hendrickson claim, K.K. 15, is situated on the south shore of Hendrickson lake, at mileage 69½ on the east boundary of the Nipigon Forest Reserve. On the east central part of the claim and surrounded by swamp, there is an exposure of rusty quartz-porphyry or rhyolite schist, about 400 feet by 50 feet, with a fringe of Iron formation of pyritic black slates on the north side. The rhyolite has been intruded by lenses and stringers of quartz, through which zinc blende and iron pyrites are finely disseminated. The quartz has been greatly fractured, the

Prospecting on the Hull vein, KK 90, June 1917.

dark seams being filled with talc, chlorite, calcite, pyrrhotite and other minerals. Gold was seen in the quartz closely associated with zinc blende. It is the intention to thoroughly prospect the deposit. The rhyolite formation is extensive in the area, and the finding of visible gold in this formation may lead to further prospecting in these rocks.

Cline

The Cline claim, K.K. 61, is situated immediately east of Tashota on the north side of the railway. Here, deep trenching has revealed an altered iron formation band, four feet wide and consisting of alternating layers of "sugary" quartz and some magnetite, with secondary pyrite bands up to two inches in width. Considerable gold could be seen in rusty slickensides over a length of six feet on the surface. The Tash-Orn Mines Limited, who have optioned the claim, sank an inclined shaft to a depth of 48 feet on the deposit and bored a diamond drill

side, 165 feet in length, at an angle of 45° towards the deposit. The company intend installing a boiler and resuming operations in the near future.

Gold Values in Other Parts

In addition to the gold deposits already described, gold has been panned and low gold values obtained from numerous other claims in various parts of the area. On the Reamsbottom claim, T.B. 2857, which lies immediately north of the Cline, gold values were found in a narrow, rusty iron formation band consisting of alternating layers of "sugary" quartz and magnetite, which strikes southeasterly, and dips 70° to the northeast. The formation contains small amounts of pyrrhotite, pyrite, chalcopyrite and native copper, and is cut by minute secondary quartz veins. The Tash-Orn Mines Limited, bored a diamond drill hole, 300 feet in length, at an angle of 70° from the horizontal towards the deposit, after which all work was suspended.

On the McKinnon claim, which lies two claims north of the Devanney is a quartz deposit, 25 feet wide in places, containing a narrow layer of disseminated galena with some zinc blende and chalcopyrite. A sample of these sulphides gave, on analysis, $1.00 of gold and 11 ounces of silver per ton.

In the vicinity of Hull lake low gold values occur in quartz veins on the contact of the rhyolite and hornblende schists.

On the Knapp-Hendrickson claim, two miles south of the Tashota gravel pit, considerable trenching and several shallow test pits have been sunk on numerous parallel quartz veins in green schists which are intruded by minute tongues of porphyry and diabase. Both the veins and the adjoining schist are well mineralized with pyrite and pyrrhotite, while molybdenite, graphite, bismuthinite and native bismuth (?) occur in smaller quantities. No visible gold has been found, but encouraging gold assays have been obtained.

Samples giving $1.00 to $2.00 of gold per ton were obtained from numerous veins in various parts of the map sheet.

Iron

Several iron ore deposits occur on the Onaman iron range in the vicinity of Paska and Kowkash stations. These were examined in detail by E. S. Moore in 1907[1] and 1908[2] for the Ontario Bureau of Mines. He found the ore to occur in two bands, called the northern and southern ranges, the former extending for nine miles, and the latter three miles, in an east and west direction. The principal deposits, viz.: the Maple Leaf, Height of Land, Winter Camp and Miller deposits on the northern range, and the Bain deposit on the southern range, are described by Moore in his report, and their locations are shown for convenience on the map accompanying this report. The Winter Camp and Miller deposits were diamond-drilled to a depth of 351 and 139 feet respectively, the core encountering material that varied very little from that occurring at the surface. Numerous bands of ore, a few inches in width, will run 67 per cent. of iron, but these are narrow and interbanded with too much slate, greywacké and tuff to be of economic

[1] Rep. Ont. Bur. Mines, Vol. XVII, 1908, pp. 170-189.
[2] Ibid, Vol. XVIII, 1909, pp. 196-253.

importance. Moore collected a sample from an outcrop about 15 feet across near the eastern end of the southern range which, on analysis, gave the following:

	Per cent.
Total metallic iron	55.79
Iron in ferrous condition	10.94
Silica	37.10

About one-half a mile west of the latter outcrop, and probably on a portion of the same band, is a jasper and magnetite formation which Moore estimates would run from 30 to 40 per cent. of metallic iron across a width of 50 feet. He regards this vicinity as one of the most favourable spots for drilling on the range. It lies two miles and three-quarters directly south of Paska station.

Iron Pyrites

In the preliminary report on Kowkash in 1915 it was stated that the prospector should be on the lookout for iron pyrites. When examining the area in 1916 the mineral was found to be widely distributed and to occur, occasionally, in such quantities as to warrant further exploration.

A pyrite deposit that can be worked at a profit must contain at least 35 per cent. of sulphur, be free from arsenic, and not contain too many impurities such as lead and zinc, and must be of good roasting quality. It should also be of sufficient size to maintain a constant supply, and favourably situated for transportation facilities.

The prices vary from 10 to 13 cents per unit of sulphur. A free roasting ore containing 40 per cent. of sulphur, furnace size, is worth at present about 13 cents per unit, which is equal to \$5.20 per ton laid down at a plant. At present there are three acid-making plants in operation in Ontario, viz.: the Nichols Chemical Co. at Sulphide, the Grasselli Chemical Co. at Hamilton, and the Algoma Steel Corporation at Sault Ste. Marie; the former two are treating customs ore. Much of Ontario's production is shipped to United States ports on the great lakes for use south of the line.

Iron pyrites is used chiefly in the manufacture of sulphuric and other acids, in the making of sulphite pulp from wood, also fertilizers, and in the refining of petroleum, etc. During recent years there has been a good market for pyrite because of the demand for sulphuric acid in the manufacture of explosives.

The more important deposits which are located on the map will be briefly described. They appear, in most cases, to be chemical sediments formed at the time the Iron formation, rhyolite schist or volcanic tuffs were being laid down.

Whitefish Lake Deposit

A prospector, Phillip Gagnon, discovered a pyrite deposit five miles to the southwest of Paska station, on the south shore of the extreme northeast end of Whitefish lake. The pyrite occurs about 300 yards south of a syenite hill, in black slates of the Iron formation type, which strike southwest and northeast. Under three feet of water, and about 15 feet from the shore, are two places which show massive pyrite, apparently of good quality and over a width of four feet. It grades, at the sides, into black slates covered by gossan in places and containing

much disseminated pyrite, often in the form of rounded nodules. Some magnetite and pyrrhotite and a little chalcopyrite are also present in parts of the formation. A sample of massive pyrite, collected from under the water, was found, on analysis, to contain no gold or nickel. The deposit warrants further exploration.

Lake St. Marie Deposit

A wide Iron formation band of varying strike and dip occurs in the rhyolites around lake St. Marie, which is two miles to the southeast of Redmond station. The rocks have been greatly brecciated, permitting the circulation of sulphide solutions. This may be the original Trombley iron deposit referred to by E. S. Moore,[10] but it is now staked by Russel and Dwyer. Within 100 yards of the northeast shore of the lake, trenching has revealed a pyrite band three feet in width. A chipped sample across three feet yielded, on assay, 31.3 per cent. of sulphur and $2.40 of gold to the ton. There was not enough work done to disclose the extent of the deposit.

Coleman Deposit

D. Coleman, a prospector, has located a pyrite deposit one-quarter of a mile north of mileage 55.7 on the railway. At this locality on the side of a large hill of cherty-looking rhyolite, is a vein-like deposit 5 feet in width containing considerable pyrite. A piece of the pure pyrite gave, on assay, $2.00 in gold to the ton. About 100 yards west of the pyrite showing, and on the south shore of a pond is a massive pyrrhotite body, 5 feet or more in width, from which samples gave, on assay, no values in gold, platinum or nickel.

Ryan Pyrite Boulder

Running north from mileage 49.75 on the railway near Paska is a surveyed trial line, which has been used as a trail by prospectors and trappers. On this line two miles north of the railway is an angular boulder of pyrite, 5 feet by 3 feet by 4 feet, lying in the rusty sand. The boulder contains a high percentage of sulphur. A sample from the boulder was found, on analysis, to contain no gold or nickel. Judging that the boulder had not been transported any great distance by the ice sheet, a search was made to the northeast, the direction from which the ice came, to locate the deposit "in place." This resulted in the finding of deposits of considerable extent by McCann and Gravelle.

McCann Deposit

Mr. McCann has done several hundred feet of trenching near the 111-mile post of Code's meridian line to Howard falls, in an endeavour to locate a pyrite deposit. The stripping has revealed gossan in the form of rusty sand and limonite below which is considerable pyrite and a mixture of pyrite and pyrrhotite, somewhat interbanded, in a cherty quartz porphyry and altered iron formation. The deposit across 50 feet would run about 20 per cent. of sulphur, there being a much larger amount of lower grade material. A sample of the massive sulphides contained no gold or nickel.

[10] Rep. Ont. Bur. Mines, Vol. XVII, 1908, p. 181.

It was reported that considerable pyrite was found on the Gravelle claims, in this vicinity.

Willet Lake Deposit

Pyrite was discovered by the writer on the small pond four chains east of the east end of Willet lake, while surveying the route. The pyrite occurs disseminated through a "sugary" quartz-schist which strikes N. 70 W. and dips vertically. Ten feet of the deposit would run about 25 per cent. of sulphur, a sample of which showed gold to be absent. If some trenching were done in the vicinity a workable pyrite deposit might be located.

Pyrrhotite

A few large bodies of massive pyrrhotite occur in different parts of the area, the locations of which are shown on the accompanying map. The deposits are of no commercial importance, but are mentioned owing to 40 or more claims having been staked in the vicinity of Marshall lake in 1912, and two years' assessment work being done on them in search of nickel and platinum. The largest body seen lies on the south central shore of Marshall lake, where an open cut through shallow gossan reveals 15 feet or more of pyrrhotite which contains a small amount of pyrite and quartz. Seven pieces of pyrrhotite from different parts of the open cut gave no value for nickel, platinum or gold. The rock directly adjacent to the sulphide is Iron formation of the "sugary" quartz type, with little magnetite. A mile and three-quarters northeast of Marshall lake, near Lower Meta lake, considerable work has been done on a rusty hornblende-mica schist containing much disseminated pyrrhotite. Samples from here also showed an absence of platinum and nickel. The 8-foot pit, three quarters of a mile east of mileage LXXXIV on the east boundary of the Nipigon Forest Reserve, was probably sunk during the same year. A sample, consisting largely of pyrrhotite with some pyrite and magnetite, an altered iron formation, showed no gold or nickel values. The pyrrhotite mass on the south shore of the pond at mileage 55.7 on the railway is also lacking in gold, platinum and nickel. The pyrrhotite mass at Rupert falls, Kawashkagama river, is reported to carry no nickel or gold. It would therefore seem that the pyrrhotite bodies in this area are not promising for gold, nickel or platinum.

Building Stone

The red and gray biotite and hornblende granites along the railway in the vicinity of mileage 57 and 71 are massive and jointed, and appear to be of a quality suitable for building stone. However, they are situated too far distant from the populated areas to be of value at present.

Travertine and Marl

A deposit of soft, white calcium carbonate or travertine, at least 20 feet thick in places, occurs in Red Paint lake, half a mile from Paska. The deposit is more fully described under the heading Pleistocene.

White marl, with a few scattered white shells, occurs in a small pond half a mile to the southeast of the Tashota gravel pit, but the thickness of the deposit

is not known. Marl is now little used in the manufacture of cement; however, it might at some time be employed in the agricultural portion of northern Ontario as a dressing for the soil.

V. CONCLUSION

The geology of the Kowkash gold area is, in a general way, similar to the geology in the other gold areas of northern Ontario. Numerous quartz veins carrying low gold values occur in the schist in many parts of the area, and at present gold can be seen on eight claims, some of which are widely separated, and in considerable amount on some of these. Prospecting as yet, has been largely confined to the surface, the deepest shaft (June, 1917) being 120 feet, on the Wells property near Tashota, where the principal development work has been done. No bullion has come from the area as yet, but some low-grade gold ore has been blocked out on the Wells claim. Several diamond drill holes have been bored on three claims. Prospecting is aided by the excellent transportation facilities.

In prospecting the surface for gold, one should trench in the green schists near the porphyry dikes and in the vicinity of the small granite intrusions; and, if possible, work should be concentrated on the more promising deposits. Other gold finds and ore shoots will undoubtedly be located. At the time of writing (June, 1917) the greatest activity is centered around Tashota.

Some of the iron pyrites deposits in the area would justify further exploration. The iron pyrites might be used in the making of sulphite pulp at the pulpwood mills in northern Ontario.

Silver in the area was obtained on assay in only one sample. However, since there are large areas of diabase around Lake Nipigon,[11] and since silver occurs in considerable quantity with the diabase at Silver Islet and Silver Mountain, 150 miles to the southwest, it would seem advisable to prospect these diabase areas immediately west of the area for silver.

[11] See map of Nipigon Lake Basin accompanying Memoir No. 1, 1910, Geological Survey of Canada, Ottawa.

LONGUELAC TO JELLICOE AND ORIENT BAY

By A. G. BURROWS

Introduction

The writer was instructed in June 1916, by T. W. Gibson, Deputy Minister of Mines, to make a general examination of an area lying along the Canadian Northern railway between Longuelac and Jellicoe stations. The west boundary of this area, which is the east boundary of the Nipigon Forest Reserve, is about 21 miles east of Lake Nipigon. The country is situated near the height of land, and is drained partly by the waters flowing into Lake Superior and Lake Nipigon, and partly by those flowing into James bay. The examination was mainly intended to inquire into the possibilities of the country for the occurrence of valuable minerals, and as a field for the prospector. The writer was ably assisted during the ten weeks spent in the field by R. H. Hutchison, of the Sudbury Mining School. Two weeks were spent in examining the schistose areas in the vicinity of Long lake and McKay lake, and as these bodies of water had been surveyed, it was possible to locate fairly well any points referred to in the report. It was then thought advisable to make a micrometer and compass survey of the routes travelled to the west of Long[1] lake, since these were only shown in a sketchy manner on the available maps. Joe Feetean and Duncan Finlayson of Longuelac were employed as canoemen in this survey, and their experience in looking up trails, etc., was of great service.

A micrometer survey was made of nearly the whole canoe route from Devilfish lake to Jellicoe; the route from Jellicoe northwesterly to the Sturgeon river, which was followed upstream to its headwaters; the route from the upper Sturgeon to Wintering lake over the height of land, and from Wintering lake to the English river by way of Little Long lake.

Early Exploration in the Area

The first report on this area was made in 1870 by Robert Bell[2] for the Geological Survey of Canada. Surveys were made of McKay lake, the route from this lake to Long lake, Long lake, and the route northerly to Devilfish lake. Bell described the geology along the route and mentioned the possible economic resources.

E. V. Neelands,[3] who was a geologist with one of the exploration parties sent out by the Ontario Government in 1900, described the geology of the country round the north part of McKay lake and the portage route to Long lake, and also that of the lower part of Little Long Lake river.

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[1] This name, like others, has been given to several lakes in Ontario. In this volume, for example, Long lake near Sudbury, where a gold deposit has been worked during recent years, is described by M. B. Baker. Such duplication of names tends to confusion, but it is difficult to avoid it, owing to the large extent of the territory embraced in the Province of Ontario, and to the fact that a change in established names is undesirable.—W. G. M.

[2] Report, Geological Survey of Canada, 1870-71.

[3] Report of Survey and Exploration of Northern Ontario, 1900.

A. L. Parsons[4] in the Eleventh Report of the Bureau of Mines also described the geology of the route from McKay lake to Long lake.

A. P. Coleman[5] described the Nipigon iron ranges, which he traced from

Post of the Hudson's Bay Company, Long lake.

Indians at Longuelac station.

Lake Nipigon to within a few miles of Beatty lake (Wawong), a few miles

[4] Geology of Thunder Bay–Algoma Boundary, 17th Rep. Ont. Bur. Mines, 1908.
[5] Iron Ranges East of Lake Nipigon, 17th Rep. Ont. Bur. Mines, 1908.

northwest of Jellicoe. The same author[6] gave a very general description of the geology of Long lake and the Iron formation on Little Long lake.

No geological work had been done in the country west of Little Long lake almost as far as Jellicoe.

The geology of the region to the west of Upper Sturgeon river, examined in 1904 by W. A. Parks, is shown on the geological map of portions of the Districts of Algoma and Thunder Bay, No. 961, published by the Geological Survey of Canada.

Alfred W. G. Wilson made a report on the Geology of the Nipigon Basin, Ontario, in which is included the geology of part of the area along the west side of the map accompanying this report.[7]

Drift-covered Areas

A considerable portion of the area is covered with drift, and a knowledge of the geology is largely derived from an examination of the rocks which occur along the shores of lakes and rivers. A great part of the drift-covered portion consists of deposits of sand and gravel, particularly in the region to the northwest of Little Long lake, and along the railway westward to Jellicoe. Deposits of gravel along the railway have been used as ballast for the roadbed. Stratified clay is found around the north part of Long lake, and clay land near the trading posts has been utilized for farming purposes by officers of the Hudson Bay Company and Revillon Frères. Stratified clay also occurs along the Making Ground river and Kenogami (English) river. Back from the river sandy and gravelly deposits are usually met with in the higher portions; the low flat muskeg areas are generally underlain by clay. Only a very small portion of the whole area would be suitable for agricultural purposes.

Glaciation and Topography

The general contour of the country is that of a peneplain. Marks of intense glaciation are everywhere seen where the rocks are exposed, the fine-grained greenstones and slaty rocks especially retaining the glacial markings. A general average of the strikes of glacial striations would be about S.W. One striking effect of glacial scouring can be seen on the southeast shore of Expansion lake on the Sturgeon river. Here the ice movement assisted by wave action, has gouged out the softer margins or ellipses of the pillow lava, giving a mamillary character to the outcrop.

Viewed in a general way the area examined is one of low relief, and seldom are hills seen which are more than 100 to 150 feet above the surrounding plain. Some of the country round McKay lake, and along the shores of Long lake to the south of Seven mile point, is rough and rugged, with cliffs rising abruptly from the water. According to Robert Bell the southerly part of Long lake is very rugged and mountainous, one hill rising 540 feet above the level. The elevation decreases northerly, and near the north end of the lake the country is rather low.

[6] Iron Ranges of Nipigon District, 18th Rep. Ont. Bur. Mines, 1909.
[7] Geological Survey of Canada, Memoir I, 1910.

Scene on Wild Goose lake.

Glaciation on pillow lava, Expansion lake, Sturgeon river.

The prevailing level is about 1,000 to 1,150 feet above the sea. The railway grade at Longuelac has an elevation of 1,031 feet. Going westward there is a gradual rise, with local differences to Keemle, which is 1,135 feet above sea level, and the highest point along the road from Longuelac to Jellicoe (1,082 feet). The extent of the drift and the paucity of the rock exposures are shown by the scattered and shallow rock cuts between these stations. To the west of Jellicoe rock exposures are more numerous, particularly on approaching the area of Keweenawan diabase near Lake Nipigon.

There is a marked parallelism in the main water courses, the general trend of which is northeast and southwest. It will be noted on the map that the Upper Sturgeon river, Wintering lake to Little Long lake, Long lake and McKay lake are roughly parallel, indicating the main valleys of the area.

Sand beach on Sand Lake, Sturgeon river, with characteristic forest growth.

Forest

This area is covered with a light growth of timber, which is generally too small to be of much value except as pulpwood. White spruce of fair size is often found along the river banks and low shores of lakes. Jack pine is very abundant on the numerous sand and gravel stretches, but is usually rather small. Cedar is found on some of the rivers like the Sturgeon and, where near the railway, some of it has been utilized in construction. The other common trees are poplar, balm of gilead, birch and balsam.

Traces of old fires are seen in many parts, while some small areas around Jellicoe and on Gamsby lake have been recently burned over.

Game and Fish

The tract, which has been little travelled except by exploratory parties, and Indians who make it their hunting ground, is an ideal country for the tourist, as game and fish are abundant. It is now easy of access since the Canadian Northern Railway traverses it, and numerous lakes and streams offer great facilities for canoe travel.

During the exploratory trip of ten weeks along water routes, nearly fifty moose and caribou were observed by members of the party, while red deer are also reported to exist.

Wild ducks were abundant on many of the lakes, especially to the south of the railway along the route from Wintering lake to Little Long lake. A flock of wild geese was also seen on Wintering lake.

The large lakes, like McKay and Long, abound in large lake trout, while nearly all the lakes yield abundant pike and pickerel. Brook trout are caught in several streams in the vicinity of Long lake, particularly at the first falls on the English river below the lake, and on Devilfish river. Whitefish are also netted by the Indians.

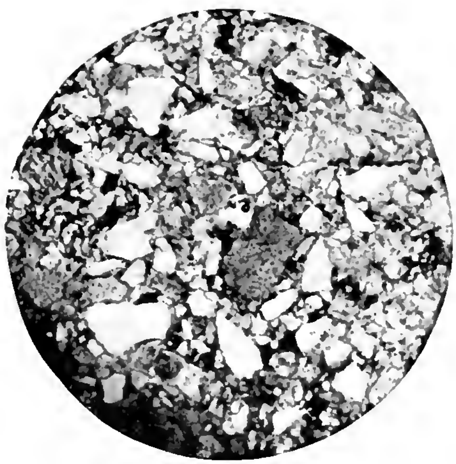
Geology

Since this examination was largely of an exploratory nature, no attempt was made to map areas in detail. However, the canoe routes and a section along the railway gave a general idea as to the geological character and distribution of the rocks. It was found that the southern part of the area included in the accompanying map is composed of granite, with some gneiss of varied colour and structure, exposures being seen on McKay, Long and Wintering lakes, and the series of lakes from Wintering to the headwaters of the Sturgeon river. On McKay lake the granite is largely in the form of dikes or small masses intruding the mica schist, but is in considerable volume in the southwest part of the lake. The same condition was observed on Long lake, about 15 miles from the north end, where for a distance of two miles, there are numerous exposures of dikes and large masses of granite in the mica schist, while to the south of this zone the granite occurs in large volume. The country along the water route to the north of Wintering lake is covered with drift, and no rock is observed until the head of Little Long lake is reached, where the rock is a hornblende schist. However, on the Upper Sturgeon river farther west, garnetiferous biotite schist, similar to that on McKay and Long lakes, outcrops; consequently it is evident that all across this area the granites are flanked to the north by garnetiferous mica schist. This mica schist, described by Bell in 1870 as "tender gray mica schist," is succeeded on Long lake and other lakes by other schistose rocks, many of which give distinct evidence of being of sedimentary origin.

To the north of the gray mica schist on Long lake, there are bands of coarse or fine-grained hornblende schist, fine-grained mica schists, quartzose schists, ash-like rocks, agglomerates, altered diabase, thin beds of Iron formation, and amygdaloidal and other basic igneous rocks, as far as Seven Mile point. Since all these rocks are quite schistose and have more or less uniform strike and dip, it is impossible to make any separation into distinct geological groups. They appear

to form part of one geological series. Somewhat similar types of rocks are seen farther west on Little Long lake, and also in the area around Jellicoe. On Little Long lake there are prominent and possibly important bands of jaspilyte or Iron formation, and fine-grained pillow lavas and altered diabase in large volume, which lie to the north of the hornblendic and micaceous schists. A large area of granite, later in age than these schists, extends southward on Long lake to Seven Mile point and westward to near the northeast end of Little Long lake, so that more of the Iron formation and lavas have been preserved on Little Long lake than on Long lake. On the Upper Sturgeon river, besides the bands of mica schist, there are outcrops of banded quartzose schists which are of sedimentary formation. Farther north, on Partridge lake, banded cherty rocks occur along the south shore, and lavas along the north shore.

South and west of Jellicoe there are exposures of pillow lavas and other volcanics, while directly north of this station at Oxaline lake there is a broad



Photomicrograph of greywacké, south shore of Oxaline lake. Magnification 20.

band of fragmental rock, much of which shows banding into coarse and fine material like greywacké. It is apparent that in the area from Jellicoe to Long lake, there is a great similarity in the schistose rocks, and that much of these is fragmental. Whether most of this fragmental material can be classed as volcanic in origin (ash, tuffs, agglomerates, etc.) or whether it may have been deposited as detritus by the weathering and erosion of other rocks, the writer is not able to state. It is apparent that igneous and fragmental rocks are everywhere intermingled, and it would be extremely difficult to separate them even if the separation were of any economic importance.

Outcrops of conglomerate, in which there is a great variety of rounded pebbles, including granite, porphyry, gneiss, greenstone, jasper, quartz, etc., occur on Beatty lake (Wawong). This conglomerate is clearly formed from material derived from weathered and eroded older rocks, and is not of volcanic origin. The latter origin might be suggested for some at least of the immense volume of fine-grained fragmentals with the lavas mentioned above.

Legend

KEWEENAWAN (?) .... Diabase, in the form of sills and dikes.

Intrusive Contact.

TIMISKAMING (?) .... Conglomerate, arkose.
(Lower Huronian of Coleman and A. W. G. Wilson.)

LAURENTIAN (?) .... Granites, gneisses, pegmatites.

Intrusive Contact.

KEEWATIN .... Greenstone, green schists, mica schists, hornblende schists, iron formation, ash rocks, agglomerates, greywacké, slate.

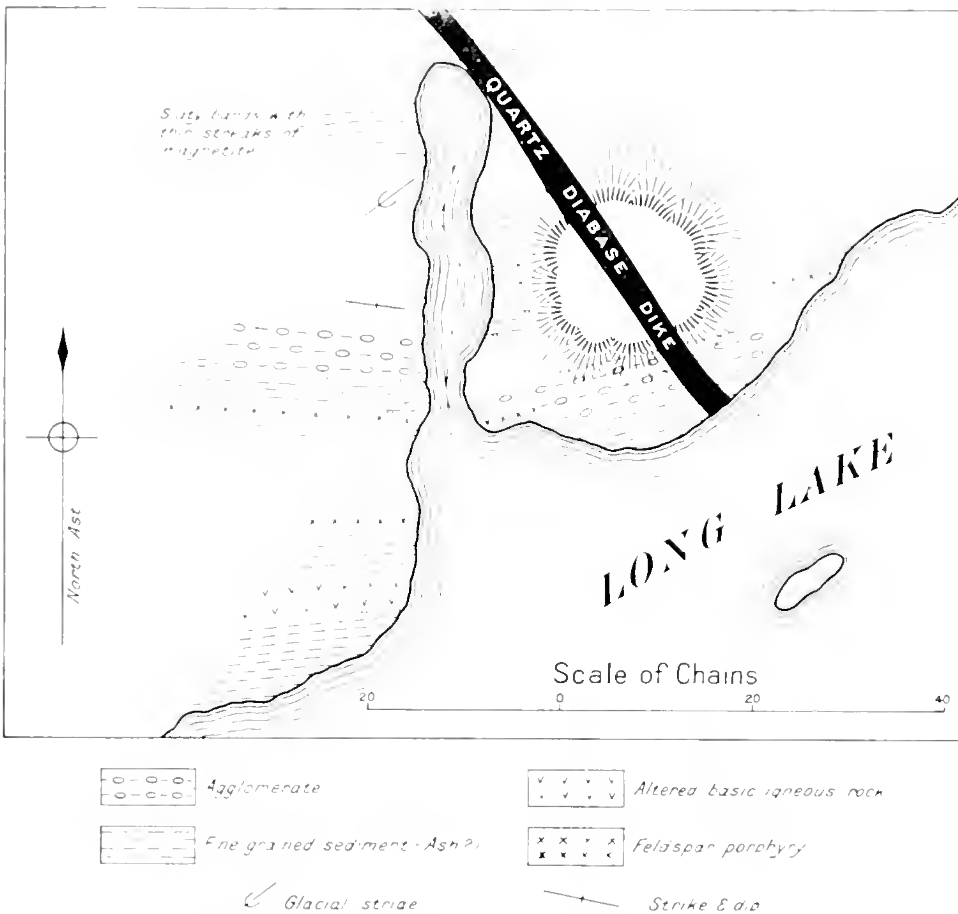
Rapids and falls on upper part of Sturgeon river.

Keewatin

From a comparison with the greenstones, green schist and associated rocks in other parts of northern Ontario which have been mapped with the Keewatin, it is probable that similar rocks in this area are of the same age. If the altered igneous rocks, such as lavas of both pillow and non-pillow structure, altered diabases and other rocks, are Keewatin, it is also likely that the great assemblage of sedimentary rocks which occur in this area are of the same relative age. These sedimentary rocks are everywhere intermingled or interbanded with the lavas.

The lavas are greatly altered, although the pillow structure is well preserved in many places. A specimen of pillow lava from one mile west of Langmuir station is dark greenish in colour, and has a clayey odour. Under the microscope it proves to be greatly altered, showing secondary feldspar (albite), hornblende, chlorite, calcite and iron ore.

A rock which resembles a diabase occurs on the south shore of Little Long lake, opposite Langmuir station. Plagioclase feldspar crystals, greatly fractured, along with quartz and a high percentage of chlorite, are recognized in thin section. This rock is likely a coarse phase of the one previously mentioned. An amygdaloidal lava occurs a mile west at the main narrows. Amygdaloidal rocks are also seen in other parts of the area. One such occurrence is on the west shore of Long lake, about one mile southwest of Seven Mile point. On a bare rocky island near the north shore of Expansion lake on the Sturgeon river, there is a



Plan of part of west shore of Long lake, showing a section of Keewatin schists intruded by feldspar porphyry and quartz diabase.

light greenish amygdaloidal rock which shows altered phenocrysts of feldspar and amygdules of quartz. This rock is a more acid type of amygdaloidal rock than that usually seen.

Good exposures of greenstone of the pillow lava type can be seen in the rock cuts northeast of Partridge lake. The rock has been much fractured and cemented with veinlets of calcite and quartz. Similar rocks occur a mile west of Jellicoe station.

Half a mile east of Expansion lake on the Sturgeon river, there is a light greenish altered igneous rock which shows laths of albite, grains of quartz and ragged masses of chlorite. The alteration has probably been from a Keewatin quartz diorite.

Long Lake

The exposures of dark coloured schists to the southwest of Seven Mile point, Long lake, indicate an assemblage of rocks of different character, but all having a schistose structure with strike from east-west to northeast-southwest. Some of these rocks are clearly of igneous origin, such as the amygdaloidal lavas and schistose greenstones, but others are as distinctly of sedimentary origin, since well-defined banding and sedimentation are in evidence. The origin of other rocks is not so clear. Much of the schist is micaceous or hornblendic, particularly farther to the southwest. The mica schist varies in colour from a black glistening rock with over 50 per cent. of biotite to a light-gray quartzitic rock with scattered flakes of biotite. The mica schist which occurs immediately north of the main granite outcrop, and is cut by numerous dikes of granite or pegmatite, is granular in character, weathering rusty brown, and is often garnetiferous. This mica schist may have resulted from the metamorphism of an impure sandstone. On the east shore of Long lake, opposite the third island, there is a light-coloured quartzitic looking rock, in which glistening scales of biotite are recognized. Under the microscope the rock has a greywacké structure, showing grains of quartz, fragments of feldspar (plagioclase and orthoclase), mica flakes, and a few fragments of basic igneous rocks. Interbanded with the micaceous schist, there are coarse and fine glistening hornblende schists which may have resulted from the alteration of igneous rocks. These schists are largely composed of greenish hornblende and quartz.

On the west shore of Long lake opposite the third island there are rocks, some of which are evidently of a pyroclastic character, occurring along a narrow deep bay stretching to the north, and also along the main shore of the lake to the north and south. Among these rocks are ash-coloured, fine-grained sediments, and coarser volcanic conglomerate showing angular and rounded fragments of light-coloured volcanics and other igneous rocks, together with banded slaty rocks evidently from some older fragmentals.

A sample of the fine-grained material having the appearance of an ash shows under the microscope abundant fragments of orthoclase and plagioclase and quartz, with the feldspars much more numerous than the quartz, in a fine matrix of chlorite, kaolin, feldspar and quartz. At the north end of the narrow deep bay there are some narrow bands of magnetite, one-eighth to one-quarter of an inch in thickness, but of no great length, interbanded with a fragmental rock somewhat like the one previously described. It contains numerous quartz and feldspar fragments in a fine groundmass with biotite, calcite and sphene. These rocks are intruded by narrow dikes of whitish feldspar porphyry and quite fresh quartz diabase. Farther south along the shore, some isolated bomb-like inclusions in the fragmental rock were recognized.

McKay Lake

Fine-grained mica and hornblende schists also occur on the northwest shore of McKay lake, while along the southeast shore biotite schist carrying garnets is prominent. About one mile southwest of Yankee bay on the lake, there is a dark schist which A. L. Parsons describes as a mica schist containing quartz and orthoclase, the grains of which minerals are surrounded or nearly surrounded by small flakes of biotite. A few minute garnets were also recognized.

Little Long Lake

Mica and hornblende schists similar to those described on Long lake and McKay lake occur near the south end of the southwest arm of Little Long lake.

Agglomerate on west shore of Long lake, opposite Third island.

One mile farther northeast the schists are distinctly banded and of a slate-greywacké type. They strike nearly east and west, and dip nearly vertically. These rocks, which are silicious, contain scattered flakes of mica, and can be traced to the northeast end of this arm, where crumpled greenish and rusty weathering bands showing crenulations and containing much carbonate are seen on a point on the west side of the lake. This rock is probably of volcanic origin. Directly north of this at the main narrows the rocks are igneous, showing pillow-lava structure and amygdules.

On the south shore of the southwest arm of Little Long lake there is a coarse-grained basic rock which is shown by microscopic examination to be an augite lamprophyre; some of the phenocrysts are fairly well preserved, but others

Camp on Little Long lake.

Sedimentary rock on west shore of southwest arm of Little Long lake.

are altered to groups of hornblende needles. Secondary feldspar and carbonate occur in the groundmass. Similar rock occurs a mile southeast of the main narrows of this lake. This rock is in the form of a dike cutting older Keewatin schists.

The description of the mica, hornblende and quartzose schists on Long and Little Long lakes is similar to that of schistose rocks in the Kowkash Gold Area which P. E. Hopkins has called the Marshall Lake series.[8]

Lawson's description of the Couchiching series[9] in the Rainy lake area is similar to that of the mica, hornblende and quartzose schists on Long and Little Long lakes. Coleman in describing the gray schists on Long lake mentions their great resemblance to the Couchiching of Rainy lake region.[10]

The age relationship between the mica and quartzose schists of sedimentary origin and the pillow lavas and other igneous rocks is not known. For the most part the sedimentary rocks stand so nearly in a vertical attitude that their relationships cannot be determined. It seems advisable to group all these rocks with the Keewatin until information is available to show that the sedimentary rocks may possibly be older than the lavas.

Iron Formation

Iron formation occurs in several parts of the area. At the first two portages on the stream above Upper Devilfish lake there is a strong local attraction, and at two places where the rock outcrops banded magnetite and silica were observed. The bands of iron ore are thin, and at the present time are not of economic importance. The rock associated with the banded iron formation is silicious, whitish and rusty weathering in places.

The largest showings of Iron formation are those at the west end of the west arm of Little Long lake, and these have been described by A. P. Coleman in a report on the Iron Ranges of Nipigon District.[11] There is strong local attraction all along the shore of this part of the lake, while the best showings of the formation are on a large island, a description of which is given by Coleman as follows:

> The most important outcrop is at the east end of a large island included in A.L. 131, where stripping discloses a width of 24 yards of iron formation intermixed with schist, some of the bands almost heavy enough to be ore. The colors at this stripping are gray and black, and there is magnetite enough to make the ordinary compass useless, so that the dial compass was resorted to; but much of the material gives a red powder, when pounded, showing the presence of hematite also. Another stripping a short distance west shows 10 yards of surface, made up of very lean iron formation, without schist, and containing some dull red jasper. The iron mineral here seems to be mainly hematite. . . . .

The iron-bearing bands are associated with greenish schist and rusty weathering Arkose-like bands. On the mainland west of the island there are streaks of iron ore interbanded with coarse and fine sedimentary bands like grit and slate.

Other bands of Iron formation occur on the south shore of the bay to the south of the entrance to the west arm where the local attraction is strong.

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[8] Rep. Ont. Bur. Mines, Vol. XXVI, 1917, Kowkash Gold Area.
[9] Geol. Sur. of Canada, Memoir 40, Archaean Geology of Rainy Lake Re-studied, p. 6.
[10] Rep. Ont. Bur. Mines, Vol. XVIII, 1909, Iron Ranges of Nipigon District, p. 144.
[11] Ont. Bur. Mines, Vol. XVIII, 1909, p. 146.

A few thin bands of magnetite were observed along the shore of a deep bay on the west side of Long lake opposite the third island.

Coleman[2] also refers to an iron range to the south of Battle Island lake (Partridge lake) where there are bands of sugary silica with a little magnetite striking east and west and occurring with green schist. These bands are reported to be of no economic importance. Bands of impure magnetite an inch in width are found in a few places, but most of the silica is almost devoid of ore.

Full accounts of the iron ranges to the east of Lake Nipigon are given by Coleman in his reports on this area.

Laurentian

The rocks included in this system are granites, gneisses and pegmatites; of these the granites occur in greatest volume, and are generally of a reddish or grayish biotite variety, although hornblende varieties are frequently seen. Outcrops of reddish biotite granite are frequent along the west shore of Long lake as far south as Seven Mile point. Similar rocks with gneiss occur at points between Long lake and Devilfish lake. On the southwest bay of the latter lake pink granites predominate with quartz, orthoclase, plagioclase and biotite. On the same bay there are outcrops of mica gneiss.

On Long lake, about 16 miles southwest from the railway, rocks of a granitic character with some gneiss stretch far to the south. Included in the granites and gneisses are pegmatites showing coarse crystallization of quartz, feldspar and mica.

On the east end of Mud lake, northwest of McKay lake, there is a coarse red granite composed of quartz, orthoclase and hornblende. To the west of Long lake along the railway there is a dark gray granite, gneissoid in part. It contains both mica and hornblende and a little augite, also quartz, microcline and plagioclase, with a few minor minerals like apatite. The name granodiorite might be more properly applied to this rock.

A gray granite from the shore of Sedge lake contains both biotite and muscovite with the quartz and gray feldspar.

Some of the pegmatite dikes which are very plentiful along the east shore of McKay lake, contain crystals of feldspar up to two inches in length, which with quartz make up most of the rock. Muscovite and biotite occur in small flakes.

The name "Laurentian" has been applied to the granites, gneisses and acidic rocks by various writers describing the rocks of this and surrounding areas, and, until the actual relationship to other rocks later than the Keewatin is known, the term is appropriate. A series of schistose conglomerates, now highly inclined, lying to the east of Lake Nipigon and near the Sturgeon river, has been mapped by Coleman and Wilson as Lower Huronian. In a later report Coleman suggests the similarity of this conglomerate to the Sudbury series at Sudbury and the Timiskaming series at Cobalt and Porcupine. The granites have not been found in contact with this series, and as the conglomerate series is highly schistose and similar in this respect to the Keewatin, it is possible that some of the fresh and

[2] Rep. Ont. Bur. Mines, Vol. XVII, 1908, pp. 153-4.

massive granites are really later in age than the series mapped by Coleman and Wilson as Lower Huronian, and accordingly may be equivalent to the Algoman granite in other areas.

Conglomerate (Timiskaming ?)

There is a series of conglomerate and associated arkose on Beatty lake (Wawong) which A. P. Coleman has classified as Lower Huronian.[13] This conglomerate contains numerous well-rounded pebbles and boulders of granite, porphyry, jasper, greenstone, etc., and is clearly a sedimentary deposit resulting from an accumulation of broken-down and water-worn fragments of older rocks. No contact was observed with the greenstones and green schists which also occur on this lake, but the greenstones are probably the older rocks. The presence of the jasper pebbles in the conglomerate suggests that these may have come from the Keewatin jaspilyte formation, which occurs in large volume in nearby areas. Coleman traced the conglomerate eastward from Lake Nipigon to Beatty lake, a distance of about 15 miles. In a later report Coleman suggests the possible relationship of the conglomerate and arkose to the Sudbury series at Sudbury and the Timiskaming series at Cobalt.[14] The writer noted the resemblance of this schistose conglomerate, standing at a high angle, to the conglomerate in the Kirkland lake and Porcupine areas, and suggests, like Coleman, that this may be equivalent to the Timiskaming or Sudbury series farther east. Since, however, no contacts have been reported between the conglomerate and Keewatin lavas, the age relationship of these rocks is not yet proved.

Both series of rocks have been subjected to extreme metamorphism and show schistose structure. The country is greatly covered with drift, which obscures the relationship. Coleman suggests that the narrow band of conglomerate scattered over considerable length and breadth may represent synclinal folds in the Keewatin preserved from destruction due to erosive agencies. The conglomerate is very much more metamorphosed than the granite which occurs in large volume some miles south and which has been mapped as Laurentian by several observers, but may be of Algoman age.

Acidic Dikes Intrusive into the Keewatin

Light-coloured dike rocks of a porphyritic character were observed at only a few places. On the west shore of Long lake, opposite the third island, there are a number of whitish weathering dikes which are in marked contrast with the dark-coloured schists. Conspicuous phenocrysts of gray feldspar, showing albite and carlsbad twinning, occur in the fine-grained groundmass of the porphyry. The rock is intersected by numerous quartz veinlets an inch or so in width. Near the contact with the older rocks some quartz veins are found, but, although promising in appearance, no gold was found on assay of a sample of quartz and schist. A similar dike rock of a reddish colour was seen at the south end of island No. 1.

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[13] Iron Ranges East of Lake Nipigon, Rep. Ont. Bur. Mines, Vol. XVII, 1908, p. 142.

[14] The pre-Cambrian Rocks North of Lake Huron, Rep. Ont. Bur. Mines, Vol. XXIII, 1914, p. 230.

At the [illegible] of Long lake, and just west of the railway station, there is a [illegible] reddish, acidic dike rock that intrudes a dark greenish-gray [illegible], fragments of which occur in the dike. There are some quartz veinlets [illegible] containing copper pyrites which have attracted the attention of prospectors.

A few felsite dikes occur just west of Kinghorn station.

One mile west of Jellicoe there is an interesting narrow dike, about a foot in width, which intrudes Keewatin pillow lava. Under the microscope it proves to be an albite porphyry showing phenocrysts of albite in a fine-grained groundmass of similar material with grains of calcite, iron pyrites and pyrrhotite. The dike contains veinlets of quartz, and in or near the quartz there are needles of black tourmaline and prismatic crystals of arsenopyrite. The dike rock with quartz veinlets gave on assay no gold.

Keweenawan (?)

Narrow dikes of fresh diabase occur in many parts of the area. From their fresh appearance and the fact that they intrude the rocks with which they are found in contact, they are presumed to be the youngest in the area. No large areas of diabase, like those around Lake Nipigon, were seen along the routes that were travelled, but one area of such diabase has been reported by W. A. Parks, and is shown in the southwest corner of the map on Parks lake, southeast of Lake Nipigon. There are several prominent dikes of diabase on McKay lake and Long lake. One of these cuts a series of fragmental rocks on the west shore of Long lake opposite the third island. It is coarse-grained, and microscopic study proves it to be a quartz diabase, consisting of plagioclase, augite and interstitial quartz with minor accessories.

On the south shore of the west bay of Little Long lake there is a fresh hornblende diabase.

On the northwest shore of Oxaline lake, there is a coarse-grained diabase in which grains of quartz and feldspar can be recognized in hand specimens. The mineral augite is seen in thin section, so that the rock is probably a somewhat acidic quartz diabase.

Numerous narrow dikes of diabase occur in the granite in the rock cuts along the railway to the west of Longuelac station.

Pleistocene

As mentioned previously, most of the area is covered with deposits of drift, consisting of sands, gravels, clays, peat and moss. Of these the sand-gravel deposits greatly preponderate.

Stratified clay occurs in a low flat near the Hudson Bay Company's trading post on the west side of Long lake, while a sandy terrace is seen on the east side near the post of Revillon Frères. Referring to the deposits along Long lake and Kenogami river, Coleman states: "Probably the sand and clay terraces were made when the ice front stood not many miles away to the north at an early stage of lake Ojibway; or they may have been formed in a narrow bay stretching

Keweenawan diabase overlying Keewatin schist with a development of analcite and prehnite along the contact. Warneford station, Can. Nor. railway.

Photomicrograph of olivine diabase from tunnel south of Fairloch, Can. Nor. railway. Magnification 20.

southward from lake Algonquin." The same author also refers to old lake deposits of sand and gravel on Little Long lake and on Sand lake along the Sturgeon river. On the Upper Sturgeon river a sand plain indicating an old lake deposit was observed toward the north end of the long portage 12 miles below Granite lake.

Boulder clay and esker ridges occur on the summit portage from Making Ground river to Mud lake. To the southwest of Little Long lake toward the Wintering lake, there are several esker-like deposits of sand and gravel on the portages along the river. To the north of Bankfield, along the canoe route from Devilfish lake to Wild Goose lake, there are morainic ridges of sand and gravel containing numerous small kettle lakes. Much of the shores of Wild Goose lake consists of boulder beds which may have been derived from morainic material.

Economic Geology

During the examination of this area no deposits of present economic value were observed along the routes travelled. However, since a large part of the area is underlain by metamorphic rocks which have been altered to schists, deposits of importance may still be found. One is struck, however, by the scarcity of light-coloured intrusive rocks of a porphyritic character, such as quartz or feldspar porphyry, which are so prominent in areas like Porcupine and Kirkland lake, and which have proved of importance for the occurrence of gold.

Gold

There are a great number of white quartz veins in parts of the area, especially around McKay and Long lakes, which are of no value. These are narrow and of white quartz, usually carry no metallic minerals, and are simply the result of the healing of the cracks which have been formed in the country rock.

Low values in gold were obtained in samples taken from quartz veins in rock cuts from Partridge lake westward to Jellicoe.

A three-inch stringer containing quartz, specular iron ore, copper pyrites and iron pyrites, from a rock cut at mileage 145, near Kinghorn, gave on assay $1.20 in gold per ton.

In a rock cut one mile to the west of Jellicoe there are several lenticular masses of quartz in the basalt. One of these, 15 inches in width, gave on assay $4.00 in gold per ton. A sample of albite porphyry with quartz, tourmaline and arsenical pyrites from the same rock cut gave no gold values on assay.

Several assays were made from quartz veins and schist from the north shore of Hutchison lake, at the headwaters of the Devilfish river, the highest value in gold obtained being 80 cents per ton.

Gold values up to $2.00 per ton were obtained from specimens of quartz, schist and iron pyrites from the shores of the west arm of Little Long lake.

A property known as the Edy claim, near the main narrows of this lake, was prospected several years ago. Visible gold is reported to have been obtained from the quartz vein on the shore of the lake. The vein cannot now be seen, being covered with sand and gravel, but chips from a number of pieces of rusty quartz showing iron pyrites and tourmaline gave on assay 80 cents per ton in gold.

Copper and Molybdenum

There are some showings of copper pyrites in a reddish dike rock on the north shore of Long lake just west of the station. These have attracted the attention of a prospector who has done some trenching and blasting, which showed up a little molybdenite in addition to the copper pyrites.

While at Long lake the writer was shown a fine sample of molybdenite in a reddish granite which was reported to have come from the southwest part of Devilfish lake, but no authentic information could be obtained from the Indians who brought the sample to the trading post.

Iron Ore

The most promising Iron formation is that on the west arm of Little Long lake which has been described by Coleman,[15] but until there is a demand for the low-grade jaspilyte iron ore of the Nipigon area, the deposit will not be of economic importance.

Acknowledgments

The writer is greatly indebted to E. H. McLeod, manager of Revillon Frères' post at Longuelac, for kindnesses extended while the party made this place its headquarters.

Plans of railroad surveys along the route examined, furnished by the Canadian Northern railway, proved useful in the field and also in the compilation of the map (No. 26b.) accompanying this report.

ORIENT BAY TO JELLICOE

Following are a few notes embodying the results of observations along the line of the Canadian Northern railway from Orient bay to Jellicoe.

Orient Bay station (elevation 858.66 ft.) is at the south end of Pijitawabik bay, the southeasterly extension of Lake Nipigon. From this station northerly as far as Fairloch station the route is quite scenic, since the railway skirts the shore of the bay with increasing elevation along the side of a diabase ridge, at one place passing through a long tunnel in the diabase. This rock, which is of Keweenawan age, when examined under the microscope proves to be olivine-bearing, showing the typical ophitic structure, with a development of labradorite in augite, and also numerous grains of olivine.

On a prominent hill to the east of Fairloch the Ontario Government has established a lookout station in connection with its fire-ranging system. To the northeast of Fairloch with increasing distance the bold topography afforded by the Keweenawan diabase gradually gives place to a more rounded and flatter surface contour as more of the Keewatin rocks are encountered.

[15] Rep. Ont. Bur. Mines, Vol. XVIII, 1909, Pt. I, p. 146.

Analcite and Prehnite

Southwest of Warneford station Keewatin greenstone outcrops, while a few yards from the station there is a cliff of columnar diabase about 60 feet high overlying greenstone schist at a low angle.

Along the contact of the diabase and schist secondary minerals have been developed. Dull white crystals of analcite, showing well developed icositetrahedral form, occur in the decomposed contact zone. Some of the analcite is also more massive along with a very light greenish mineral which E. Thomson of the Mineralogical Department of Toronto University recognized under the microscope to be the acid silicate, prehnite. Of the two minerals the prehnite is of earlier

Pigitawabik bay, lake Nipigon, as seen from the Canadian Northern railway.

crystallization, the analcite being isotropic, with optical anomalies, and the prehnite showing very brilliant interference colours. An analysis of crystals of analcite made by W. K. McNeill, Provincial Assayer, shows the following composition: SiO_2, 50.98 per cent.; Al_2O_3, 23.2 per cent.; Na_2O, 10.42 per cent.; CaO, 2.10 per cent.; MgO, 1.16 per cent.; H_2O, 7.45 per cent. This is a very interesting occurrence of analcite, since the mineral has hitherto been reported in only one locality in the Province, namely, at Heron bay, Lake Superior, where it occurs as a constituent of a rare rock to which Dr. Coleman gave the name "heronite." Prehnite is more widely distributed, having been found along the north shore of Lake Superior in the copper-bearing formations.

One-half a mile east of Warneford, near the crossing of the Blackwater river, which the railway now roughly follows as far as Blackwater lake, the last outcrops along the railway of the Keweenawan diabase showing vertical columnar structure are observed. Beyond this, there are Keewatin fragmental rocks with a general strike of N. 65° E. and dip 75° N. to within a mile west of Beardmore, where there are greenstone schists. The fragmental rock contains a number of quartz veins which, however, on assay contain no gold values. At the east end of the siding at Beardmore station, there is a medium-grained diabase dike probably of Keweenawan age.

East of Beardmore to Jackpine, there are only a few outcrops showing banded slaty rocks cut by narrow diabase dikes. Between Jackpine and Nezah the country

Blackwater lake, near Jellicoe. The illustration shows the peneplain character of the country.

is covered with sand or muskeg. A diabase dike outcrops on the siding near Nezah station.

From Nezah to Blackwater lake there are only a few outcrops of a banded greywacké-like rock, probably Keewatin in age.

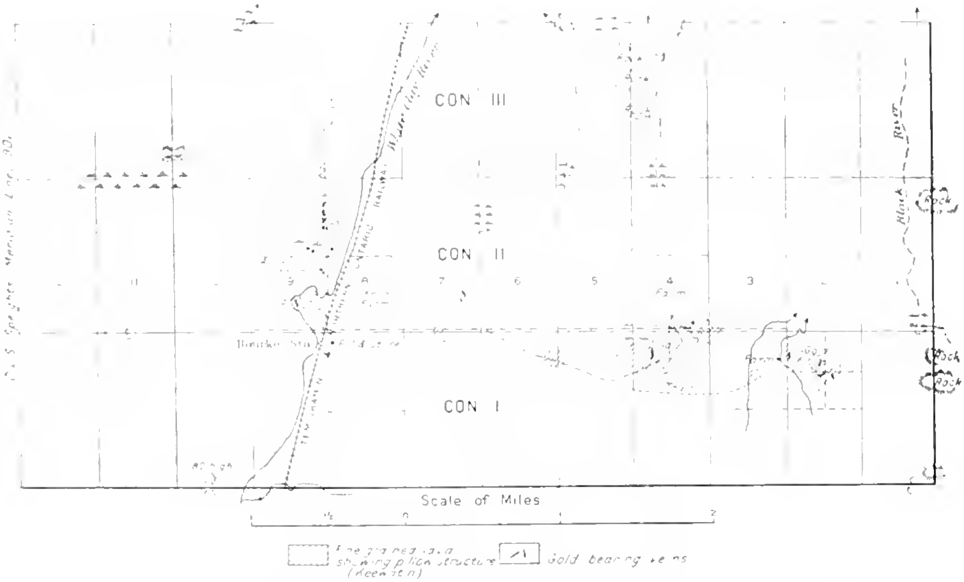
One mile west of Jellicoe there is a long rock cut through an altered pillow lava which contains whitish rounded inclusions like spherules. In this rock there are lenticular veins of quartz carrying low gold values, and a narrow dike of albite porphyry.

Jellicoe, altitude 1,082.50 feet, is located on a flat sand plain which is evidently an old lake deposit formed in Pleistocene times.

GOLD-BEARING VEINS IN BENOIT TOWNSHIP

By A. G. BURROWS

Benoit township is on the line of the Timiskaming and Northern Ontario railway, 50 miles northwest of Cobalt and a few miles northwest of the Kirkland Lake gold area. Some interest in the township resulted from discoveries of gold during 1916. Several quarter sections have been taken up for homesteads in the vicinity of Bourke station. Most of the township is drift-covered, while the northwestern part is largely sandy. There are a few outcrops of rock in the southerly part of the township, which rise as low ridges in the drift.



Plan of south half of Benoit township showing geology and location of gold veins.

Geology

There is little variation in the rock, which for the most part is greenstone of Keewatin age, often fine-grained and with pillow-lava structure. The rock under the microscope proves to have been greatly altered to chlorite, calcite, albite and other secondary minerals. A rock which forms the hanging-wall of the Wickstead quartz vein is a fine-grained greenish-black metabasalt. Some very fine lath-like plagioclase feldspars can be recognized, but these are largely altered to chlorite and other secondary minerals, while the ferromagnesian mineral is also altered to chlorite. Small patches of calcite are abundant as an alteration product. A sample from the pit on the flat veins on the Skognshi claim is very similar, only coarser in grain.

The greenish tinge of the basaltic rock is due to an abundance of the secondary mineral, chlorite.

In an exposure of rock on the Anderson farm, along the creek near the railway track some of the greenstone has an amygdaloidal texture.

Gold Bearing Veins

Anderson Farm

The chief interest centred in a discovery of gold which was made on the Anderson farm by its former owner, Oscar Anderson. This farm is located in the

Quartz vein on Wickstead claim, Benoit township.

second concession of Benoit, on the south half of lot 9. The gold occurs in the rusty-weathering quartz-schist band in the greenstone. This band strikes N.W. and S.E. in a low outcropping in a bend in the White Clay river. Very little work has been done, beyond a small amount of stripping with a shot on the showing. The question of ownership of the farm became involved in litigation, consequently there has been a cessation of work. Where the stripping was done, a hundred feet from the river, there are several showings of native gold in the decomposed quartz-schist outcrop. As far as could be observed from the small

amount of exposure, the deposit has the character of a shear zone in which there are lenses of quartz along its strike; at one point this rusty zone is about three feet wide. Some of the quartz lenses are about a foot in width. The rock accompanying the quartz is greatly impregnated with iron pyrites which, on the surface, is very much oxidized; calcite is also abundant in the rock. Some specimens of oxidized material showing coarse gold also contain a dark gray mineral with metallic lustre, which proved on testing to be a telluride of gold and silver with 26.88 per cent. of gold, the mineral being probably petzite.

Owing to the small amount of work done the economic importance of the deposit is problematical, but the discovery is one which warrants investigation.

Flat-lying parallel quartz veins in greenstone, Skogski claim, Benoit township.

Wickstead Claim

The Wickstead claim is situated in the first concession of Benoit, being the N.W. quarter of the N. half of lot 1. The vein strikes about N. 25° E., and occurs in greenstone which has a pillow-lava structure. It dips at a low angle to the west, varying from about 15° to nearly horizontal, and has been exposed by trenching for about 210 feet. It is a quite distinct vein of white quartz, averaging probably a foot, although in some places it is two feet in width. The quartz is of a milky white colour, and in a few places is stained by the oxidation of iron pyrites. Visible gold is reported to have been found in several places along

the outcrop. At one place the vein has a pegmatitic appearance, there being fragments of a porphyry dike enclosed. Beyond stripping or following the outcrop no prospecting work has been done.

Skognski Claims

This group of claims comprises the N. half of lot 2 in the first concession of Benoit. Native gold has been found in a number of quartz veins. Most of the work has been done on the N.W. quarter of the N. half of lot 2, where two pits have been made on a series of flat-lying quartz veins in a fine-grained Keewatin lava; in one pit, about eight feet deep, there are five of these narrow veins exposed, varying in width from about an inch to three inches. The quartz contains considerable iron pyrites, especially along the contact with the greenstone, while in the wall rock for a few inches from the veins there is crystallized iron pyrites. A few assays of $2.00 to $9.00 per ton are reported in sections of quartz and rock.

In the southeast part of the same lot, there is a brecciated porphyry-quartz vein in the basalt that averages about a foot in width and has been traced for 150 feet. Gold and iron pyrites were observed in a few places along the vein.

A wider vein from two to eight feet in width occurs at the northeast part of the S.W. quarter of the N. half of the same lot. This vein also shows remnants of a porphyry dike, although most of the vein material is quartz. No visible gold was observed, but low gold values are reported to have been obtained. No systematic sampling of these veins had been done, consequently their economic importance has not been proved.

GOLD IN GAUTHIER TOWNSHIP

By A. G. BURROWS

The township of Gauthier is included in the geological map (No. 23a.) of the Kirkland Lake and Swastika areas published in 1913 by the Ontario Bureau of Mines. Since a considerable portion of the township was not examined at that time, and as discoveries of gold had been reported on the Elstone-Dunkin claims, it was thought advisable to revisit this area for a few days in September, 1916. It was found, however, that much of the unexamined area is covered with drift, with here and there small outcroppings of rock. There were only a very few prospectors operating in parts of the township in the autumn of 1916. Gold had been discovered some years before (1912) on a group of claims in the north-east part of the township which now composes the holdings of the Mine d'Or Huronia. Some years before this a shaft had been sunk on claim L. 529 by the Victoria Mines Company, and diamond-drilling had been done by another company on a prominent Keewatin outcrop on the south boundary of the township; in neither case apparently with very satisfactory results.

Much of the western part of the township consists of rolling jackpine sand plains and sand ridges, stretching from Larder lake around to Victoria lake. Most of the rock is in the easterly part of the township. A great part has been burned over in recent years, and travelling is fairly easy as compared with that in most of northern Ontario.

Geology

The rocks outcropping in this township are all referred to the pre-Cambrian. The oldest rocks belong to the Keewatin, and are largely represented by greenstone and greenstone schists. Certain sedimentary rocks (slate, conglomerate) are referred to the Timiskaming series. Both the Keewatin and the Timiskaming are intruded by a number of rocks of lamprophyric and porphyritic type. These intrusive rocks are probably equivalent in age to similar rocks which occur around Kirkland lake, and which are referred to the Algoman.

Keewatin

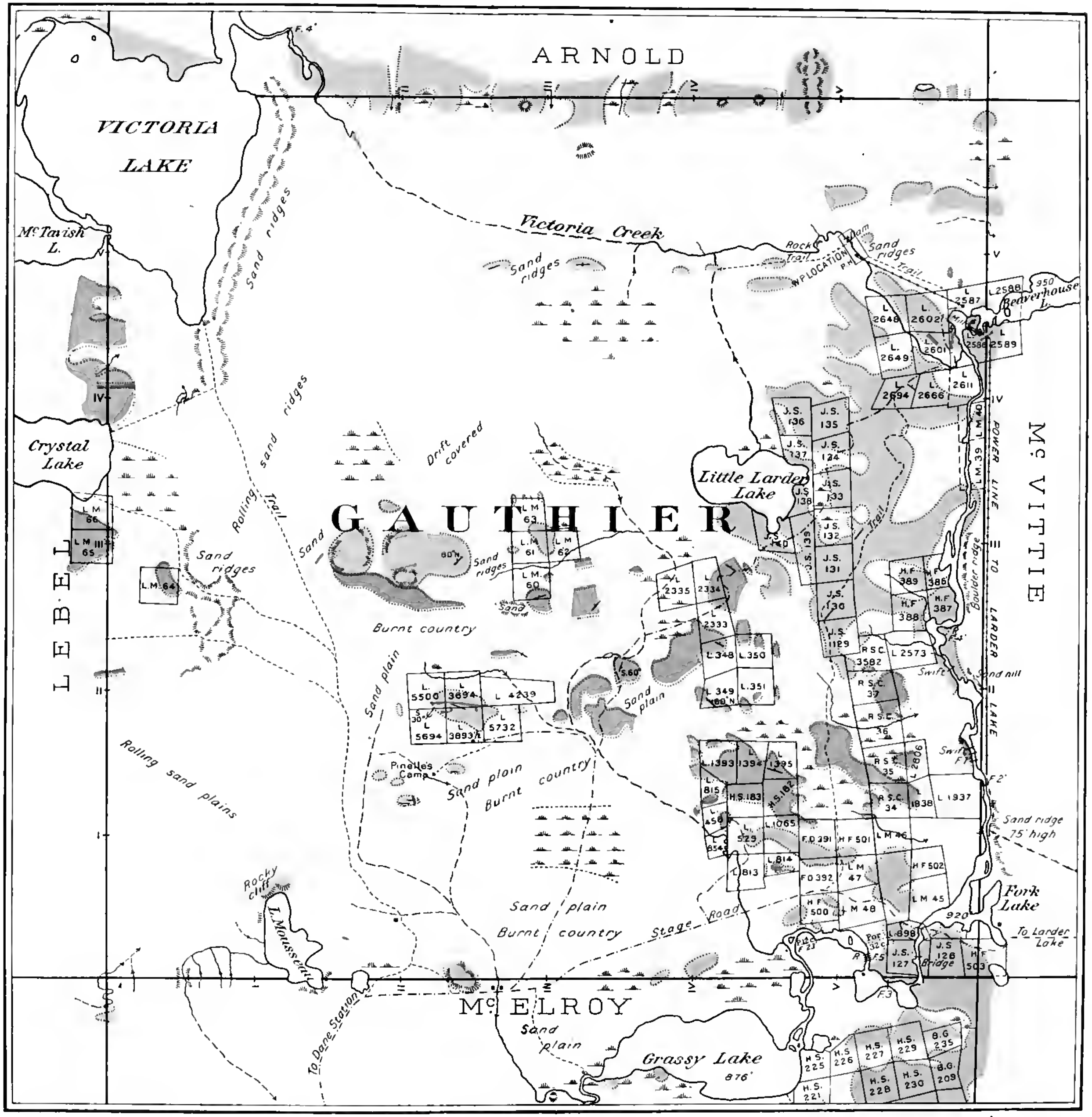
Masses of greenstone, associated with narrow bands of Iron formation, occur in isolated exposures to the southwest of the Elstone claims, L. 3891 and L. 3893½. These rocks contain some disseminated iron pyrites, and are often rusty-weathering on the surface. Fine-grained basic igneous rocks showing the ellipsoidal structure, are seen on the Elstone claims and enclose a mineralized zone in which native gold occurs. The fine-grained greenstone on claim L. 5732 is probably an alteration from a basalt. It now contains abundant chlorite, calcite and secondary feldspar.

Fine-grained lava, which frequently shows the ellipsoidal structure, forms the main part of the exposure on the west side of the expansion of the Blanche River

Map No. 26d.

TOWNSHIP OF GAUTHIER

To accompany Report by A. G. Burrows, in Vol. 26, Part 1, of the Ontario Bureau of Mines, 1917.



LEGEND

Glacial and Recent

Uncoloured areas are largely drift.

PRE-CAMBRIAN

INTRUSIVES

Feldspar, quartz and granite porphyry.

Lamprophyre & porphyry.

INTRUSIVE CONTACT

Timiskaming

Slate, conglomerate (now greatly altered to schists)

Keewatin

Pillow lava, old diabases, rhyolite and other light coloured lavas, greatly altered to schists; iron formation, rusty weathering carbonate-serpentine rock

Symbols

Shafts
Strike & Dip
Strike & Vertical Dip
Buildings
Trails
Roads
Swamps
Hills

Mining Locations

L 2587, L 2588, L 2586, L 2589.
MINE D'OR HURONIA
L 3894, L 3893½, L 5732.
ELSTONE-DUNKIN

W. J. Bell, *Cartographer*

Scale of Miles

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immediately west of Beaverhouse lake. A number of narrow quartz veinlets, which are auriferous, have been discovered in this exposure. Frequent outcrops of a similar rock occur northward to the north boundary of Gauthier. Here some of the lava is amygdaloidal, an example of which type can be seen one-half mile west of the northeast corner of the township. Greenstone outcrops frequently to the north of Victoria creek as far as Victoria lake, at the extreme northwest part of the township. Intermingled with the fine-grained lavas, there are coarser-grained rocks of a diabasic character. Such an intermingling of fine and coarse rocks has been observed repeatedly in Keewatin areas in northern Ontario. Many of the Keewatin rocks are extremely schistose, as in the area to the east and southeast of Little Larder lake. Some of the schists are very light-coloured and fine-grained, and have probably resulted from the alteration of felsitic and rhyolitic rocks, while others are dark green, indicating an origin from basic rocks. All these schists are greatly impregnated with calcite and other carbonates. On claim E.D. 391 there is a serpentinous carbonate rock which shows considerable of the bright green chromiferous mica, fuchsite. This variety of rock is frequently observed to the north of Larder lake. It is often intersected by quartz and calcite veinlets, and much prospecting had been done along the band. Similar rocks are of frequent occurrence in Deloro township in the Porcupine area.

Timiskaming Series

The Timiskaming series is shown on the map of the Kirkland lake and Swastika gold areas as extending in a broad band across the townships of Teck and Lebel, and in isolated outcrops in Gauthier township. The sediments are much better preserved in the west part of the area than in Gauthier township, where no contacts were observed with other rocks which are referred to the Keewatin. Several contacts were observed in Teck and Lebel in which there is an unconformity between the Keewatin and Timiskaming, consequently the conglomerate and slates, which are believed to be similar to those in Teck and Lebel, though more greatly altered, are placed in the Timiskaming series. These sediments are largely fine-grained whitish-weathering soft rocks that are greatly impregnated with calcite and other carbonates similar to the Keewatin. A schistose conglomerate occurs on claim L. 349. It contains scattered pebbles of porphyry, quartz and black cherty rocks like Iron formation. Along the Huronia mine road to the north of the Elstone turn, there are several outcrops of altered sediments as far as Little Larder lake. These rocks strike mostly to the north of west, and have a highly inclined dip to the north. The series contains masses of dark schist, which have probably been formed from basic intrusions into the sedimentary series.

While these sediments are here classed as Timiskaming, owing to their similarity to those in Teck and Lebel, it is quite apparent that the metamorphism has been as great or greater than that of the igneous rocks of the Keewatin.

M. E. Wilson in his report on the Larder lake area[1] classifies the slate-like rocks in McVittie township with Keewatin, and in his discussion of their origin states:

> The slates and dolomites may have been laid down contemporaneously with the original volcanic flows . . . . although there is a possibility that they entirely or in part overlie the greenstone, and have been infolded.

Owing to the lack of exposure contacts, which even when found are often obscure, there is considerable doubt as to the true relationships between the sedimentary slates and conglomerates, and the volcanic rocks which are classed as Keewatin. Wilson maps the mashed conglomerate on the north side of Larder lake with the Huronian, but states that it may be equivalent to the Timiskaming conglomerate described by Dr. W. G. Miller, Provincial Geologist, at Cross lake in the Cobalt area, since both conglomerates are intruded by lamprophyritic dikes. Mashed conglomerate, similar to that at Larder lake, occurs in a series with fine-grained sediments on claims L. 1393 and L. 1394 in Gauthier township.

Intrusive Rocks

There are a number of intrusives that are younger than the Timiskaming and Keewatin. About three-quarters of a mile north of claim L. 3894 there is a prominent hill which is composed of altered green rock that varies considerably in colour. Some of the reddish rock under the microscope indicates a feldspar porphyritic structure, since remnants of broad plagioclase crystals can be recognized in the fine-grained groundmass. Other rocks are quite dark in colour, and, while very much altered, numerous phenocrysts of ferro-magnesian mineral, probably augite altered to secondary minerals, can be recognized. This rock is very similar to the lamprophyric rock which occurs in large volume to the north of Gull lake in Lebel township. On the hill just westward there are several dikes of feldspar-porphyry, like the one near Kirkland lake. Similar dikes occur in other parts of the township. Usually the dikes are less than 50 feet in width, and some of them are only a few inches. Some of these very narrow dikes occur on the west ridge at the Huronia mine. To the south of the mill at this mine, there is a reddish felsite dike, 11 feet in width, which carries native gold along with veinlets of magnetite and copper pyrites. A thin section of this rock shows a fine-grained quartz-feldspar matrix, with a few small crystals of hornblende and numerous minute veinlets of magnetite.

An acidic dike about 30 feet wide with large phenocrysts of quartz and plagioclase feldspar, intrudes greenstone and Iron formation in an outcrop a quarter of a mile southwest from C. Pinelle's camp.

Granite porphyry occurs on claim L. 811 to the north of the Larder Lake road.

A rock with a syenitic appearance in hand specimens, occurs just north of the buildings at the Huronia mine. It is composed of feldspar and hornblende. The phenocrysts of feldspar are somewhat clouded, but occasionally show multiple twinning.

[1] Memoir 17 E., Geol. Sur. Can., Ottawa.

Gold Deposits

Mine d'Or Huronia

In the year 1912 gold-bearing veins were discovered to the west of Beaverhouse lake along an expansion of the Blanche river. The prospectors who located the claims sold to a company which operated the property under the name "La Mine d'Or Huronia." Considerable prospecting was done on the ridge to the west of the Blanche river, and several narrow gold-bearing veins were located. These veins, usually only a few inches in width, are roughly parallel and strike N. 40° E. Reddish felsitic or porphyritic material usually occurs along the walls of the veins, suggesting a relationship between the quartz veins and porphyritic dikes. The sulphide minerals in the veins are iron and copper pyrites. Masses of copper pyrites, several pounds in weight, are sometimes met with, and these

Workings on west hill, La Mine d'or Huronia, Gauthier township.

frequently carry small fragments of reddish feldspar-porphyry. Grains of magnetite can be observed in some of the vein material; calcite occurs in minor quantity. On the east side of the expansion of the Blanche river and a few hundred feet south of the mill there is a reddish felsitic dike, about 11 feet in width, which has been traced some distance, with a strike of N. 170° W. In this dike there are veinlets of magnetite, which are usually parallel to the walls of the dike. One of these is about four inches wide, and is almost all magnetite accompanied by some copper pyrites and quartz. The dike occurs in basic Keewatin rock. Native gold occurred in several shows on the surface of this dike in minute quartz veinlets. A shaft was sunk to a depth of 102 feet in the porphyry dike.

Most of the work was done on the west side of the expansion. An open cut was made on one of the wider veins on the summit of the ridge, and from this cut some ore was sent to the mill. A shaft was sunk at the open cut to a

depth of 65 feet. A tunnel was also driven from near the shore of the lake, and a shaft was sunk a short distance to the south of the 100-foot level, and a cross-cut run to the north to intersect veins which showed on the surface. Most of the ore treated in the mill came from the west side of the lake, and was trammed across the lake on a floating tramway.

The property has been operated intermittently for several years. A mill was constructed consisting of 15 stamps, a tube mill, Dorr classifier, three concentrating tables, two slime tables and a cone classifier. The concentrates were stacked for future treatment. The mill was run for a short time in the autumn of 1916. A sample of the fresh concentrates assayed $36.40 per ton in gold, and 5.69 per cent. copper. The mill is electrically driven by power supplied from Raven falls, south of Larder lake.

Altered Keewatin basalt and chert with lenticular quartz mass. Elstone-Dunkin claim, Gauthier township.

A very complete examination of the property was made in 1915 by A. Paré for N. A. Timmins who had the property under option, but the option was not exercised.

Elstone-Dunkin Claims

Early in 1916 a discovery of gold was made on three claims which are located in the central part of Gauthier township, where a low ridge of greenstone (pillow lava) outcrops from the sand plain. By means of cross trenches a mineralized band has been traced for about 20 chains on mining claims L. 3894 and L. 3893½, the greater part of the work having been done at the northwest

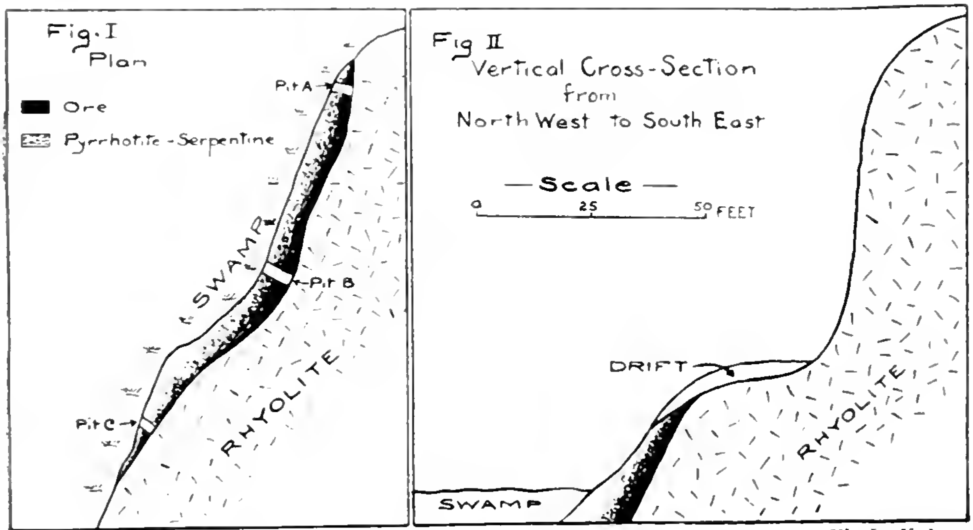
part of the band. In places the mineralized zone which strikes N. 60° W. has a width of over 20 feet, and where stripped is quite rusty-weathered, due to the oxidation of disseminated iron pyrites. Native gold, some in quite coarse grains, was observed at a few points, and an attempt was being made to locate an ore shoot in the mineralized band, which usually shows low gold values on assay. A section exposed in one cross trench shows from the northeast hanging-wall of greenstone six feet of fine-grained greenish altered rock, four and a half feet of reddish porphyry greatly fractured and containing a number of quartz veinlets, one foot of fine silicious material resembling chert with parallel bands of fine-grained iron pyrites, two and a half feet of very rusty-weathered altered rock showing considerable iron pyrites and lenses of white quartz in the direction of the schist, and seven feet of similar rock to the greenstone footwall. Some of the showings of visible gold occur in the 21½-foot section just described. This pyrites band appears to be largely the result of alteration of the greenstone along a line of weakness in which a porphyry dike has been formed, the greenstone having been replaced by a fine-grained greenish silica. A short distance to the north there is a narrow feldspar-porphyry dike, which can be traced across the property. Gold is reported to have been found in veinlets to the north of this porphyry dike.

ALEXO NICKEL MINE, TIMISKAMING DISTRICT

By M. B. BAKER

Introduction

An area that has attracted recent attention as a source of nickel is situated 150 miles due north of Sudbury in the clay belt of new Ontario. At various places in the Porcupine area and farther north in the district of Timiskaming, masses of serpentine have been found, many of which show the presence of pyrrhotite which is frequently nickeliferous. The best of such deposits yet discovered is located on the township line between lot 12, in the third concession of the township of Clergue, and lot 1 in the same concession of the township of Dundonald, and has been given the name of the Alexo mine, from the name of its discoverer, Alex. Kelso.



W. L. Uglow.

Ideal plan and section of Alexo nickel deposit.

The clay belt of northern Ontario, as has been frequently pointed out, is a great level or slightly undulating plain, with few rock outcrops, but these few have proved interesting economically, and indicate a generally rich and important series of rocks, could they be seen. Mr. Kelso was an early settler in this region, and is a close student of technical reports. In reading the report of the surveyor who ran the township base lines of this district, he noted the reference to great magnetic disturbances, rendering the needle useless at this point on the north and south line. Mr. Kelso, therefore, decided to prospect the location, and in 1908 found at the foot of a rocky hill, Fig. 1, much gossan, with greenish-white nickel bloom, morenosite. Assays of the samples collected showed good nickel values.

The rush to the Porcupine gold area, the land-trail to which passed over this deposit, overshadowed the humble prospect. A drilling option was taken by the Canadian Copper Company, and after an apparently unsatisfactory investigation the option was dropped. The owners, however, were not discouraged, and decided to open up the property themselves. E. F. Pullen (now Major, overseas) undertook the management, and in 1912 shipped 1,350 tons of ore to the Mond Nickel Company at Victoria Mines. The property has continued to ship since that time, and by the end of December, 1915, had developed 60,000 tons of ore above the 120-foot level.

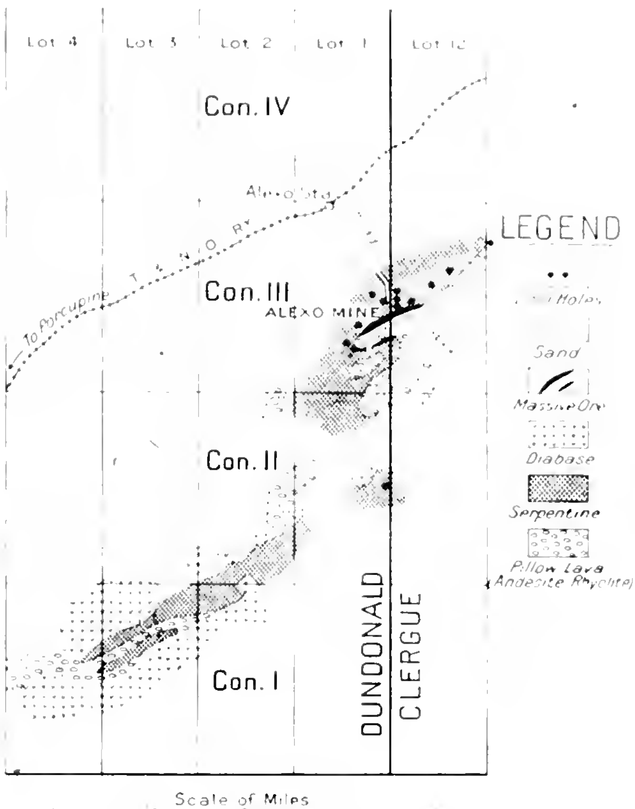


Fig. 3.—Geological map of Alexo nickel mine and vicinity, townships of Dundonald and Clergue, Timiskaming district.

During 1916, the company did no further development work, but continued to ship regularly as much ore as possible. It is the intention, however, to sink further, and develop other levels, as soon as power can be spared for this purpose.

Several short papers have been written on this nickel occurrence by A. P. Coleman and W. L. Uglow[1], but as none of these have been published since

[1] Ont. Bur Mines, Vol. XVIII, 1909, Part I, pp. 23-24, A. P. Coleman. Economic Geology, Vol. V, 1910, pp. 373-376, A. P. Coleman. Ont. Bur. Mines, Vol. XX, 1911, Part II, pp. 34-38, W. L. Uglow. Journal Can. Min. Inst., Vol. XIV, 1911, pp 657-677, W. L. Uglow. Dept. Mines, Can., "The Nickel Industry," 1913, pp. 112. A. P. Coleman.

the property was sufficiently developed, it was thought advisable to have it more carefully examined and described. The writer, therefore, spent part of the past summer on this work. C. W. Knight, of the Ontario Bureau of Mines, spent two weeks on the property in 1915, and kindly placed data collected by him at the writer's disposal.

Geology

The rocks of this area are of four ages, and in descending sequence are as follows:—

PLEISTOCENE.

Till, stratified clays, sand and gravel.

PRE CAMBRIAN.

KEWEENAWAN .... Quartz diabase and olivine diabase.

(Intrusive contact)

PRE-ALGOMAN .... Peridotites now altered to serpentine.

(Intrusive contact)

KEEWATIN .... Pillow lava, andesite, with abundant ellipsoidal structure.

Keewatin

The oldest rocks in the area form a series of very compact, hard pillow lavas of dense texture, and of greenish-gray colour when freshly broken. There seems little doubt that they are the characteristic Keewatin pillow lavas, so abundant in northern Ontario, and whose age is no longer questioned. Only twenty miles to the southwest of this, A. G. Burrows has found similar rocks overlain by Timiskaming sediments.

There has been some discussion as to whether these Alexo rocks are andesites or rhyolites. They have been called rhyolite by both Uglow[2] and Coleman[3], but the latter in his most recent report[4] has named them andesite. As a matter of fact both andesitic and rhyolitic types are found, one passing into the other, so that the name andesite-rhyolite may be a convenient term to use. C. W. Knight attempted to obtain an average sample of the rock, which, on being submitted for analysis to W. K. McNeill, Provincial Assayer, gave the results, No. I, in the table below. The other analysis, No. II, was made by W. L. Uglow[5]; it is clearly a rhyolitic facies of the rock.

	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	Loss on ignition.	Total.
I...	49.13	16.94	8.54	6.80	10.46	1.97	3.32	0.91	2.34	100.41
II...	74.08	11.10	1.42	0.61	0.49	0.25	4.15	7.42	0.25	99.77

[2] Ont. Bur. Mines, Vol. XX, 1911, Part II, p. 34.
[3] Ont. Bur. Mines, Vol. XVIII, 1909, Part I, p. 23.
[4] Dept. of Mines, Can., "The Nickel Industry," 1913, p. 112.
[5] Jour. Can. Min. Inst., Vol. XIV, 1911, p. 665.

There is no doubt that both phases of the pillow lava are intimately mixed, but the bulk of the rock is the more basic, andesite. Microscopic examination of sections taken from the surface, the contact, and from the cores of drill holes, all show the presence of abundant plagioclase feldspar, and subordinate amounts of pyroxene, in a very fine-grained felsitic aggregate. In many places the pyroxene is in appreciably large crystals, like phenocrysts in a finer grained feldspathic groundmass. This characteristic is of much importance, and will be referred to later in discussing the origin of the ore itself.

The pillow lava is so much harder than any other rock of the district that it always stands up as a prominent feature of the landscape, and forms the high hill at the Alexo mine, at the northwestern base of which the ore occurs.

Pre Algoman

The great Algoman granitic intrusive period appears to have been opened or immediately preceded by a more basic phase of intrusion in most parts of Ontario. In many places these pre-Algoman intrusives are lamprophyric dikes,

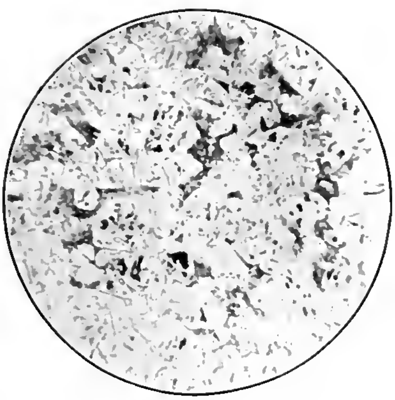


Fig. 4.—Peridotite altered to serpentine. The dark mineral is diallage and secondary serpentine. There is no sulphide present. Magnification ten diameters.

Fig. 5.—Part of fig. 4 enlarged to 30 diameters. Note the black magnetite within the olivine crystals only. Interstitial filling is diallage.

but in many other cases they are substantial boss-like masses of gabbro, pyroxenite, or peridotite. A large percentage of them consist of this last rock, so that many areas of serpentine are now reported from the northern part of Ontario, which are the result of alteration of original peridotite masses.

At the Alexo mine a large mass of peridotite is in contact with the pillow lava on its northwestern flank. The softer peridotite forms the low, flat, more or less swampy ground about the andesite hills. This is an important point for prospectors of this rock. It is almost invariably the lowest ground to be found in the areas in which it occurs. That these masses are post-Keewatin in age, is clear, since in many cases they contain fragments of the andesites as inclusions near their contact. Beyond this, the age cannot be established at the Alexo mine, but a few miles southwest, A. G. Burrows reports similar serpentine masses which are cut by

granite porphyry dikes of Algoma age.[6] The writer confirms this conclusion after visiting the location cited.

The peridotite at Alexo is now highly altered, and consists largely of serpentine, together with smaller amounts of diallage, magnetite, chromite and calcite or dolomite. Veinlets of asbestos, a small fraction of an inch long, intersect the rock in many places. The serpentine has resulted from the decomposition of olivine, and abundant pseudomorphs still preserve the crystal outlines of olivine; *see* microphotographs. In the decomposition of the olivine much magnetite dust has resulted, which is still retained within the pseudomorphs of serpentine after olivine.

From the chemical analysis given below, which is almost that of pure serpentine, it is apparent that originally this rock was composed almost entirely of olivine. It had a little interstitial pyroxene, diallage, and was therefore a wehrlite. In the process of alteration, the olivine has been changed to serpentine, with the customary development of dust-like particles of magnetite scattered throughout the pseudomorphs of the olivine. Calcite and dolomite have also been developed in the process. The diallage is still present as such, and forms an interstitial filling among the crystals of serpentine, Figs. 4 and 5.

The chromium is an original constituent of these peridotites, and is reported from most of the serpentine area already referred to. The following analysis of the rock, which was made by W. L. Uglow,[7] shows it to contain 1.65 per cent. of Cr_2O_3, 9.40 per cent. iron oxides, and 0.59 per cent. of nickel oxide.

SiO_2	Al_2O_3	Cr_2O_3	Fe_2O_3	FeO	NiO	MgO	H_2O CO_2	Total.
35.33	4.04	1.65	6.00	3.40	0.59	37.31	12.30	100.62

Keweenawan

Dikes and intrusive masses of the typical Keweenawan diabase are to be found cutting the andesite at the Alexo mine, and also the serpentine a mile southwest of the Alexo, on the south half of lot 2, concession II, township of Dundonald. The Keweenawan is a very widespread formation in northern Ontario, and is made up for the most part of diabases, traps and gabbro intrusives. These cut the Algoman as well as all earlier rocks. In other parts of northern Ontario a series of sedimentary rocks which overlie the Algoman unconformably, and which are, therefore, of Animikie age, are cut by similar diabase dikes and bosses, so that the Keweenawan age of these latter rocks is fixed. In the vicinity of the Alexo mine, there are no Animikie rocks. It can only be said, therefore, that the diabase is post-Algoman, but the perfect similarity of material and structure seems to justify the correlation of these basic intrusives with the proven Keweenawan of other areas. A microscopic examination of them shows that they are quartz-augite diabases, whether fine or coarse in grain. They all show beautiful ophitic texture, with the lath-like plagioclase feldspar cutting into and through

[6] Ont. Bur. Mines, Vol. XXIV, 1915, Part III, p. 26.
[7] Jour. Can. Min. Inst., Vol. XIV, 1911, p. 663.

the larger honey-coloured crystals of augite. They are remarkably fresh and undecomposed, and are the youngest of the pre-Cambrian rocks in the area. This diabase is characteristically associated with nickel throughout Ontario, and may have played an important part in the formation of the Alexo ore body. This phase of the question is discussed later under the origin of the ore.

The Ore Body

The ore body at the Alexo mine lies at the contact of the pre-Algoman peridotite with the earlier Keewatin pillow lava. It is associated, genetically, with the peridotite or serpentine, and not with the pillow lava. The ore is of two distinct types. The first is disseminated throughout the serpentine rock which preserves its original texture in every respect, Fig. 7; the second consists of solid or massive sulphides which occupy spaces or cracks along the actual contact and even fine veinlets, and fractures in either wall. The contact of the two rocks strikes northeast and southwest, and has a dip of 65 to 80 degrees to the northwest. The deposit has a proven length of about 700 feet, and has been opened up to a depth of 120 feet. Diamond drilling has proved ore at a depth of 240 feet. The width of the ore body, counting both the massive and disseminated ore, is quite variable. On the 120-foot level, e.g., it is 40 feet wide, while at places in the first level it is not over three feet wide, Fig. 6. Development work thus far done shows it to average 8 to 10 feet. This offers a very satisfactory working width for drifting, sinking, or even stoping, as it requires but little timbering.

The massive ore consists for the most part of pyrrhotite and pentlandite, with traces of chalcopyrite and pyrite. The nickel-holding sulphide, pentlandite, occurs in very fine veinlets through the pyrrhotite, but can only rarely be seen with the naked eye. Polished and etched pieces of the ore show the pentlandite very finely scattered through it in filaments. Chalcopyrite is not at all abundant, and occupies small fractures through the ore, as if introduced later than the pyrrhotite, or else leached from the ore body into small fractures which developed in it. Pyrite is more abundant, and often forms quite a proportion of massive ore. Pyrrhotite is much the most abundant sulphide present, and forms a massive deposit resting directly on the andesite foot-wall, in perfectly sharp contact. When broken down in mining, it leaves a sharp and smooth wall. Small veinlets extend into fissures in the andesite, but are just as clearly separable from their walls as is the main vein.

The hanging wall of the massive ore is disseminated ore, wherever the original vein structure has not been disturbed by faulting. The normal structure clearly shows the foot-wall of andesite, often vertical, or even reversed so as to become for the moment a hanging wall, against which, irrespective of its dip, lies massive ore in sharp, clean cut contact. This massive ore varies from a few inches up to 20 feet in width. It is followed by disseminated ore from three to 20 feet wide. The contact between massive and disseminated ore is quite as sharp and clean cut, as is that between massive ore and andesite, and stringers or off-shoots of massive ore penetrate the disseminated ore, all of which shows clearly that the introduction of the massive sulphides was undoubtedly

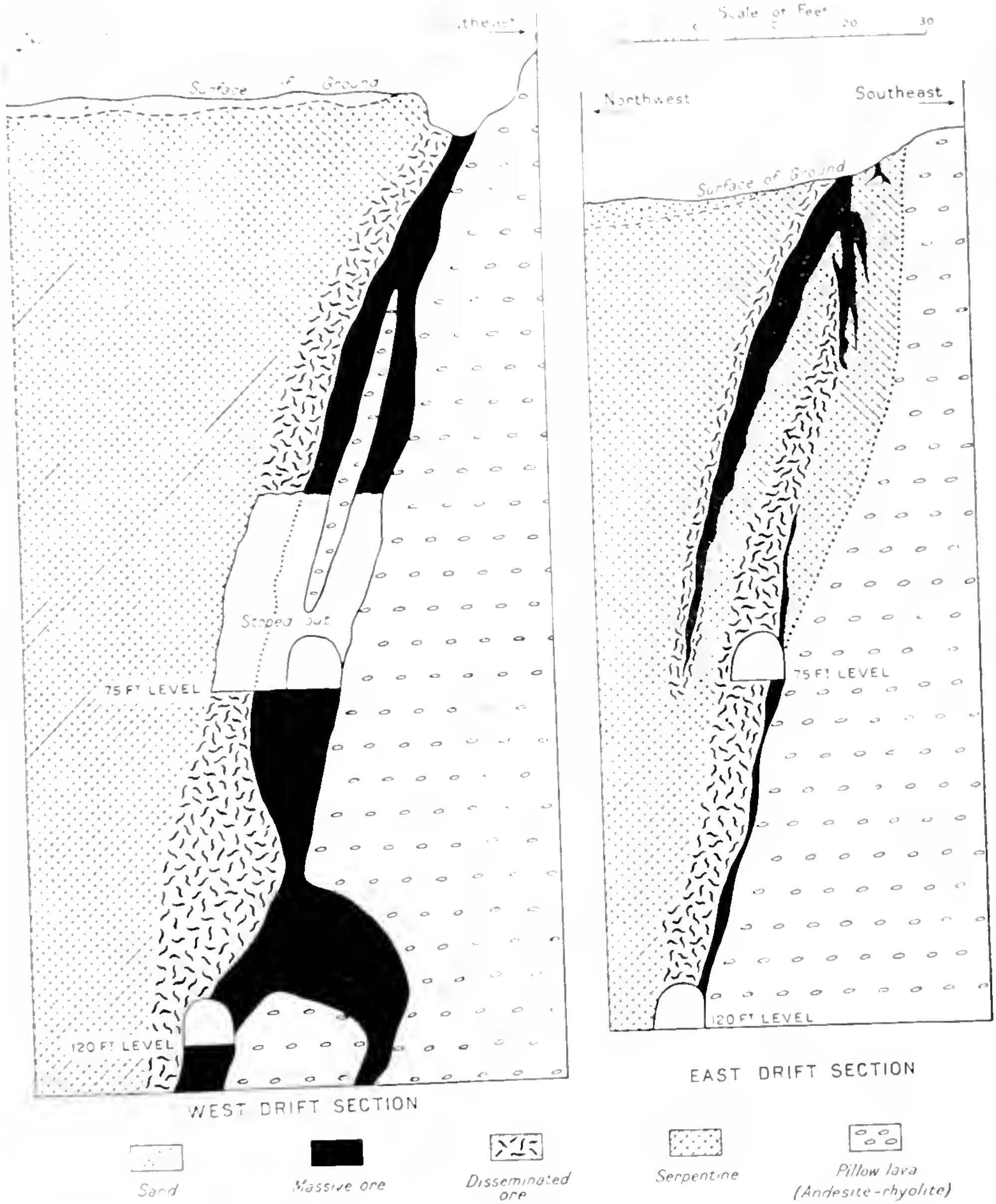


Fig. 6.

Fig. 7.

Sections across east and west drifts of Alexo nickel mine, townships of Clergue and Dundonald, Timiskaming district.

later than the formation of the disseminated ore. Since Coleman and Uglow examined this deposit, much work has been done underground, permitting a closer examination of the ore body than was possible at that time. They contend that the massive ore, the disseminated ore (so-called "pyrrhotite serpentine") and serpentine blend into one another. This is certainly not the case, for slickensides actually exist between the massive and the disseminated ore. The sections, Figs 2 and 3, show those relationships very well, and are to scale.

The disseminated ore, as the name would suggest, is scattered throughout the rock, forming part of its texture and structure. It grades off into barren serpentine, and is mined as far as it proves economical to do so. Beyond the transitional facies from disseminated ore to serpentine rock, the latter is barren of ore. This is well shown in a cross-cut on the 75-foot level, which runs for 18 feet into the hanging wall. Specimens of this rock examined under the microscope shown no pyrrhotite, Fig. 4.

The massive ore carries 6 to 8 per cent. of nickel: while the disseminated ore carries about 3 per cent. They are mined and shipped together in the ratio of about 40 per cent. of massive to 60 per cent. of disseminated ore. Carloads of this mixed ore run about 1½ per cent. of nickel. It is a valuable ore for the smelter on account of the magnesium content of the serpentine. The Alexo ore contains less than one per cent. of copper.

Origin of the Ore

The origin of the disseminated ore is not clear. Coleman and Uglow in their descriptions of this deposit differ widely in their opinion as to the origin of the ore. Coleman compares the deposit to the nickel-copper ore bodies at Sudbury, and argues that the analogy is so close that one naturally turns to the same theory in explaining its origin, viz., magmatic segregation.[2] It may be pointed out, however, that the origin of the Sudbury ores is still in dispute, many believing that they were deposited from solution. Uglow, on the other hand, says that the Alexo ore was the result of metasomatic replacement of the serpentine by sulphide solutions.[3] A study of the ore body, and microscopic examination of polished ore specimens, and of thin sections, by the writer, cause him to discard both of these theories, and the following evidence is submitted in support of his views.

The original peridotite was composed of olivine, diallage and traces of biotite in a well crystallized aggregate, a photomicrograph of which is shown, Fig. 4. Here the olivine crystals, now converted to serpentine, can still be distinctly seen. Their perfect outlines and texture are preserved in every case. Among the pseudomorphs of serpentine after olivine can be seen a dusty gray substance as an interstitial filling. This filling is diallage and serpentine. There is no pyrrhotite whatever to be seen in this rock, which was taken from the cross-cut on the 75-foot level, and about 18 feet from the contact of the andesite. The black opaque mineral showing is this section in magnetite, and is entirely confined within the olivine crystals. The magnetite may possibly

[2] Dept. of Mines, Can., 1913, "The Nickel Industry," pp. 112, 113.
[3] Ont. Bur. Mines, Vol. XX, 1911, Part II, p. 37.

have been the first mineral to crystallize from the magma, but as none of it shows crystal outlines, the writer believes that it is simply the dusty magnetite that results from the alteration of olivine to serpentine, and is secondary. The olivine is, therefore, the first formed or oldest mineral present in the rock.

Sections were taken from this point to the contact of the massive ore, and form a most interesting and instructive series in discussing the origin of the disseminated ore. The second section, Fig. 5, is a portion of section 1 enlarged to 45 diameters, to show more clearly these relationships. The magnetite (black) is seen to be wholly within the olivine crystals. The brownish black interstitial filling among the olivine crystals is a mixture of diallage and serpentine.

Figure 8 shows the almost barren rock just on the edge of the disseminated ore. Here the solid black pyrrhotite can be seen instead of diallage, and outlining the olivine crystals as perfectly as did the diallage, but not impregnating them at all. The dusty, black magnetite is still seen within the pseudomorphs of olivine.

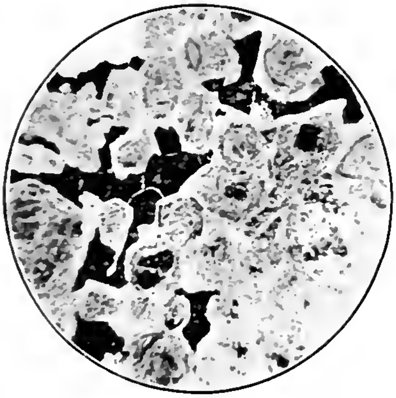


Fig. 8.—Showing idiomorphic crystals of olivine with magnetite enclosed. Also showing lean ore; the dense black interstitial filling here is sulphides. Magnification ten diameters.

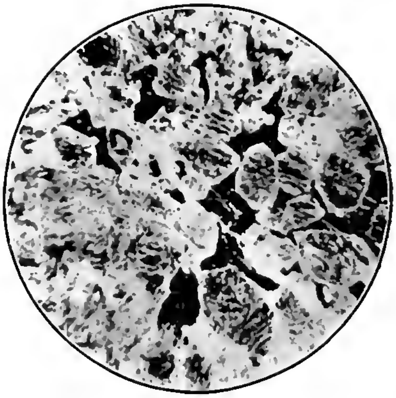


Fig. 9.—Shows sharp, clean-cut olivine crystals imbedded in sulphides, no replacement. Magnification ten diameters.

Figures 9, 10 and 11, show this pyrrhotite groundmass carried more and more to completion, and richer and richer ore resulting, as the margin of the peridotite is approached. It is instructive to note that even in Fig. 11 when the pyrrhotite is most abundant, the olivine crystals themselves are still intact and unreplaced. They contain only the dusty black magnetite as before.

The Replacement Theory

Regarding Eglow's theory of replacement, it may be pointed out that even in the richest of the ore, the original olivine crystals are quite sharp, clear-cut, and unattacked. Their outlines are as distinct as in any peridotite, and it is evident that they formed before the pyrrhotite and were not attacked by it. This is well shown in all the photomicrographs, but particularly well in Fig. 11. It might be claimed for the replacement theory, that the sulphide solu-

tions replaced the diallage, working from the contact inward. This does appear possible, but the writer would point out that the percentage of diallage is not sufficient to account for the richness of the disseminated ore, even if every vestige of it were replaced by pyrrhotite, and this is not the case, for even the best ore shows scattered diallage through its interstices. Still further, there is no evidence of the gradual attack of impregnating solutions, which is always visible in leaner ores, where the replacement is incomplete. This is well shown in Fig. 3, plate I. Replacement by solutions does not satisfy the conditions met.

As a further evidence against the substitution theory, the writer would call attention to the andesite foot-wall of the deposit. Figure 12 shows a photomicrograph of the andesite taken about 100 feet from the contact. The long white crystals of plagioclase are interwoven with pyroxene (dark). The chemical analyses given above also show that the rock is as basic as a diorite in many places. Fig. 13 shows the same andesite broken from the actual contact of the ore body, and the pyroxene can still be seen, unreplaced by sulphides. If

Fig. 10.—Richer ore, but still preserving the same relationship between olivine and sulphides. Magnification ten diameters.

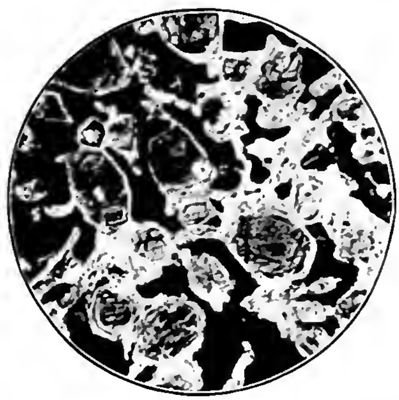


Fig. 11.—Rich ore where olivine crystals are entirely submerged or surrounded by sulphides. Magnification ten diameters.

impregnating solutions had attacked the pyroxene of the peridotite wall, it would also have attacked the same mineral in the other wall. It is perhaps superfluous to point out that the present inclination or dip of the contact plane is no indication of its dip at the time of the deposition of the ores.

Theory of Magmatic Segregation

Turning to the alternate theory of magmatic segregation, as advocated by Coleman for this deposit, the writer would point out that it also does not quite meet the requirements, but does appear more nearly to do so. It has been shown already that the massive ore is clearly of later age than the disseminated, and cannot possibly represent material that, being most basic, crystallized first and settled out along the base of the intrusive body. The writer has just shown

that [illegible] crystallized before the pyrrhotite in the disseminated ore, so that a view of magmatic segregation which involves the sinking of the pyrrhotite as the first formed mineral, to the base of the intrusive body, does not satisfy the conditions met with in either the disseminated or the massive ore.

It is pointed out above that the massive ore is in perfectly sharp contact with, and in many places actually penetrates, the disseminated ore. In many cases fragments of disseminated ore are entirely enclosed in massive ore, so that there is no doubt the latter is of later age than the disseminated, and occupies fractures in the serpentine rock, the andesite, or actual contact openings between the two, made by some later local movement. This movement may have been dynamical, or what is more likely, may have been merely due to the shrinkage of volume that the peridotite would suffer in cooling. This would cause the mass to shrink away from the andesite, producing spaces along the actual contact, and also smaller fractures in the disseminated ore and serpentine rock itself. If these changes took place in the closing phases of the peridotite intrusion, it

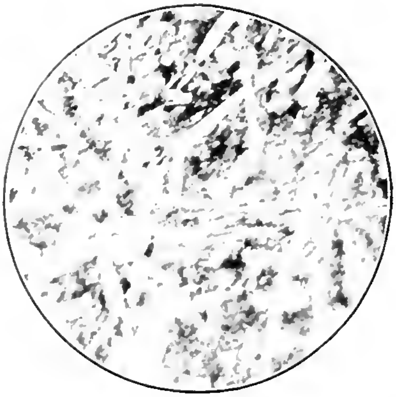


Fig. 12. Magnification thirty diameters. Andesite about 100 feet from the contact.

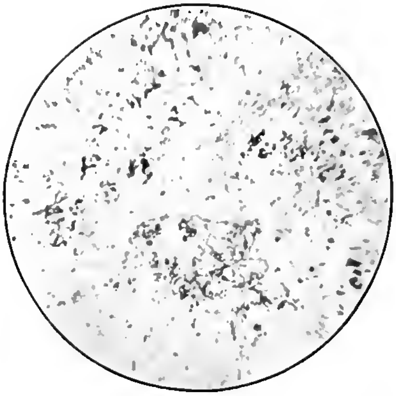


Fig. 13.—Magnification ten diameters. Andesite broken from the contact of the ore body.

would be easily possible for them to re-open channels to depth at which the metallic sulphides were still in thermo-solution, and they would ascend to fill the contacts, as well as smaller fractures in either wall.

It is, of course, possible that the massive ore is very much later in age than the disseminated ore, and may not have been introduced till the diabase intrusions of Keweenawan time, which are abundant in the area under discussion. Testing this theory, the writer found one small vein of mixed sulphides in a body of diabase on the Alexo property, from which he chipped out a sample of the sulphides, free from rock materials, and had it analyzed for nickel, but it did not carry a trace. Since even the apparently barren serpentine rock, away from the ore bodies, carries 0.59 per cent. of nickel oxide, the writer is satisfied that the source of the ore is in the peridotite intrusion itself.

The Probable Origin

That sulphide minerals may crystallize from a magma has been proven experimentally, and there is no doubt that this also occurs in natural rock magmas. The sulphides of economic importance are almost wholly confined to basic rocks, e.g., gabbros, norites, pyroxenites, and peridotites. These are all deep-seated crystallizations in which, as fused solutions, the sulphides are usually the latest minerals to solidify. In the peridotite now under discussion, olivine is almost the only mineral present, and it crystallized first. The sulphides being of greater specific gravity, and still fusible at the crystallizing temperature of the olivine, would sink to the base or margin of the body, but the load of accumulated olivine crystals on the residual "mother liquor," would cause some of the olivine to sink into the sulphides. These latter would soon fill all the interstices and solidify, forming sharp contacts with the already submerged olivine crystals, as is so well shown in the photomicrographs of the ore. The nickel-holding pentlandite was the last mineral of all to solidify, and is thus found in little filaments or veinlets ramifying throughout the pyrrhotite and chalcopyrite. The sulphides, therefore, were an original constituent of the peridotite magma, and took their turn like any other constituent, in the crystallization of the mass. This explains their occurrence at, and about, the margins of the intrusive rocks in every case. Any theory of later introduction has to meet this difficulty, for it is not easy to explain why the invading solutions should always be confined to the actual borders and contacts. The mere mechanics of such a theory are against it.

The writer considers the later massive ore a final invasion by the last residual ore solutions from the deepest portions of the peridotite magma, after its upper and outer portions were already solid, and which by further cooling shrank away from their surrounding walls in certain cases. The writer favours this origin as against the much later Keweenawan injection, because of the lack of nickel in the vein cutting the diabase on this same property; and also because of the difficulty of explaining why nickel injections, of two such widely separated ages, should strike twice in the same place, so to speak, and that place not over 700 feet long and five to eight feet wide.

To summarize then, it seems clear that the disseminated ore was formed by magmatic segregation within the peridotite body proper, and that this segregation was the last material to solidify rather than the first. It settled to the base, or outer margin of the peridotite, by its greater specific gravity, and froze, as it were, a large percentage of the already formed crystals of olivine in its body.

After the whole mass had become solid, it still continued to cool and therefore to shrink, and re-opened a channel along its contact to deeper portions of the mass, where solidification had not yet taken place, thus allowing the sulphides to well up and fill all actual openings and fissures and so form the massive ore. This means that there will be places in the area where disseminated ores occur without any massive ore being present, while there may be places where massive ores are found with no disseminated. The Alexo mine is chiefly valuable because both types occur together, yielding a good shipping product. It is doubtful whether it would pay to mine and ship the disseminated ore alone. A local

sible to [illegible] treat [illegible] at a profit. The ore appears to be [illegible] suited to concentration by flotation.

Movements Affecting the Ore Body

Since the formation of the ore body there has been local movement which has caused appreciable faulting, in addition to much minor slipping with well developed slickensiding. One fault, striking north and south, crosses the vein about 100 feet west of the main shaft. This fault can be easily seen on the surface on top of the hill just south of No. 2 shaft, where the horizontal displacement can be directly measured as 22 feet. A second fault, or another limb of the same fault, passes more or less longitudinally through the ore body. Its dip is approximately 45°, which is much flatter than that of the contact, so that it crosses the latter. From the direction of gouges and grooves on the fault walls, the movement can be seen to have been such that the peridotite or hanging wall, has moved down and westward.

This faulting is well shown in the two sections, Figs. 6 and 7, accompanying this report. In the upper level of the east drift section, the massive ore is shown resting on a foot wall of disseminated ore and peridotite. In this case the massive ore, from its contact with andesite, has slid down and out over peridotite as shown in the section. In the lower level of the west drift section a large block of andesite can be seen to have slipped down and westward from its former position. A line from the displaced ore on the upper level at the east end to the displaced body on the lower level at the west end about indicates the line of actual displacement.

In addition to this larger movement, there have been innumerable small slips throughout the peridotite, so that it is very much broken up, and everywhere shows abundant slickensides, with secondary serpentine, re-crystallized along many of the minute planes. This separation is not of the fibrous asbestos, but dense green serpentine in small but solid veinlets.

Other Serpentine Areas

There are other discovered areas of serpentine in northern Ontario, and no doubt many more undiscovered ones, that are of much economic interest. About one and a half miles southwest of the Alexo mine on the north half of lot 3, in the first concession of the township of Dundonald, serpentine masses are found in contact with andesites, containing appreciable amounts of disseminated nickeliferous pyrrhotite as at the Alexo mine. Minute stringers of massive sulphides are also found. While the associations are identical with those at the Alexo, no work has yet been done to prove their actual commercial value. These areas are shown on the small map which accompanies this report, Fig. 3. They are now under investigation by prospectors and may prove of value for nickel.

During the early spring of 1916 another interesting serpentine area was discovered by Dan O'Connor on lots 6 and 7 in the fifth concession of the township of McCart. A small sketch map, Figure 11, shows the areal relationships. The geological associations are identical with those at the Alexo mine. Ridges of andesite with a northeast and southwest trend form the prominent features of

the area. In the lower surrounding country the rocks are serpentine, which both field and microscopic examination show to be the same as that at Alexo. The original rock was an augite peridotite, composed of olivine for the most part, with augite in lesser amount. The olivine has now gone entirely to felt-like pseudomorphs of serpentine, the outlines of the original olivines can be distinctly seen, and the black iron oxides are again confined to the olivine crystals, as was the case in the serpentine of the Alexo district, and shown in the photomicrographs, figures 4, 5, 8, 11. Further description of this serpentine is not necessary, since it is in every respect like that at the Alexo mine.

The serpentine is in intrusive contact with the andesite, which shows ellipsoidal structure, and a somewhat schistose texture. The strike of the schist is north 30°

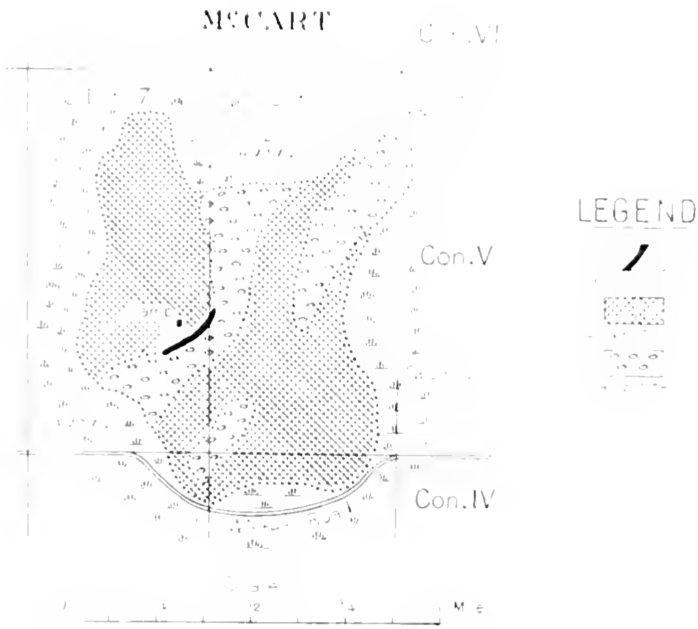


Fig. 14.—Plan showing association of nickeliferous pyrrhotite with serpentine, McCart township.

east, and the dip is to the northwest at about 65°. The microscope shows the andesite to be fine-grained and much re-crystallized. Fibrous to radial actinolite is abundant, and in many places has altered still further to sericite, so that the rock in many places is a sericite schist.

On lot 7 in the fifth concession, as shown in the sketch map, the serpentine and andesite are in sharp contact, and associated with the serpentine close to this contact is disseminated pyrrhotite, containing nickel, and small stringers of massive sulphide are also present which carry as much as 3 per cent. of nickel. It is very significant that the association here is identical with that at the Alexo mine. An explanation of the occurrence has already been suggested by the writer, and need not be repeated here.

Along this contact, on lot 7, is another very interesting rock. It is a black schist or slate-like mass, quite dense, but very platy or slaty in texture. In the field the writer took it for a carbonaceous slate, but on examination under the

microscope it proves to be an ash-rock or tuff, made up of small angular fragments of siliceous material, and shows a bedded structure, with much graphitic material along all its fractures, bedding planes, or other lines of weakness. This ash-rock is therefore a fragmental phase of the andesitic volcanic flow, and shows such perfect bedding that the fragments appear to have settled in the presence of water. There is the most perfect bedding and alignment of material, even when viewed microscopically. Similar ash-rocks, associated with ellipsoidal lavas, are reported by Burrows in the Porcupine district.[3]

Pyrite

It is mentioned above that disseminated nickeliferous ore, as well as small veins of massive pyrrhotite carrying nickel, are found close to the contact between the serpentine and andesite. While working about these contracts for nickel-holding ores, Mr. O'Connor discovered an interesting and somewhat unique deposit of iron pyrites. Scattered through the ash-rock or tuff are small round ball-like concretions of iron pyrites. They vary in size from that of peas, to balls two inches in diameter. In places there is a layer six feet or more in thickness, where these ball-like concretions are so packed together, as to be almost touching each other. It is the writer's belief that below water level this pyrites would tend to become massive, and if so, would form a possible source of the sulphide for the extraction of sulphur dioxide, so much needed in the wood pulp industry of northern Ontario.

Chromite

Chrome iron ore is universally, and almost exclusively, found with peridotite rocks. It frequently occurs as large segregations or masses which have separated out of the basic rock magma during the process of solidification. Such masses are quite irregular in shape, and have no definite walls or margins, but grade off into the peridotite rock. At other times chromite occurs in veins, pockets, or contacts, where it appears to have filled fractures, joint planes, or other lines of weakness in the rock. These openings seem to have been filled from a pneumalitic or after period of the intrusion.

No deposits of the former kind were seen by the writer in northern Ontario, but small stringers or veinlets of the latter type were found, none, however, suggesting economic possibilities. The serpentine masses show scattered grains of chromite in many places, and analyses up to 8 per cent. chromium were obtained, but it would require at least double this percentage to make it possible to treat such a rock for its chromite contents. Some evidence of concentration is shown in masses of serpentine which have a blotched or spotted appearance, the blotches being nests of chromite from an inch to three inches in diameter. Such an occurrence is well shown on the line between lots 1 and 2 in the second concession of the township of Dundonald. It would be strange indeed if a country so rich in a rock, that is in turn so rich in chromium, should not yield some economic deposits of this metal, when careful prospecting is done over the whole area. The writer would suggest that the margins of serpentine masses be examined wherever exposed, for concentrations of chrome iron ore, because this oxide would

[3] Ont. Bur. Mines, Vol. XXIV, 1915, Part 3, p. 12.

be one of the first to crystallize out of the magma, and would therefore likely settle to the base and edges of the peridotite mass in which it occurs.

Serpentine has been reported from several other parts of northern Ontario, among which the following may be mentioned: in the Porcupine gold area some fifteen or twenty miles to the southwest of the Alexo district. Several areas of serpentine here have been mapped by Burrows and Hopkins, and are shown on map No. 24 D.[11]

North of Porcupine about twenty-five miles, in the township of Beatty, special interest has been attached to these serpentine areas on account of the discovery of microscopic diamonds in them. Platinum and chromium were also found in the rock, but none of these minerals were present in large enough quantities to have commercial value.[12]

In Coulson and Warden townships a few miles south of Lake Abitibi, areas of serpentine have been mapped by Hopkins and Greenland.[13]

Serpentine was also discovered in 1908 by the writer on the east shore of Lower Lake Abitibi.[14] Analyses showed that the rock contained 6.72 per cent. of chromium.

Asbestos

Another product of great economic value that may be expected in close association with these serpentine masses is asbestos, a fibrous form of serpentine. It has been mentioned above that the peridotite rocks of this area are completely altered, and that the olivine has changed to serpentine. This is not merely a matter of weathering, but a deep-seated alteration or metamorphism brought about by mineralizing solutions, for the most part silicious or calcareous in character. These alterations of the olivine to serpentine are accompanied by an increase in volume of the whole rock mass, which brings about great variations and irregularities of pressure, so that the re-crystallized serpentine shows at least three modes of occurrence. First, there are seams or veins of fibrous asbestos or chrysotile, in which the fibres are packed tightly together, and are oriented at right angles to the walls of the seam or vein. Second, there is so-called massive serpentine where bands or seams of dense, compact, even grained serpentine occurs; and third, the altered rock itself which preserves the texture of the original plutonic rock, but the crystals of olivine are now serpentine pseudomorphs.

Microscopic examination of all three of these shows that they are after all much the same thing. They are all fibrous in texture. Even the so-called massive serpentine is a closely packed, felt-like aggregate of minute fibres in every conceivable orientation. The crystals of olivine in the third type show little nests or spots of the compact, felt-like serpentine just described, but along every little crack or cleavage plane, the minute fibres are packed in crosswise to the line of fracture, and the fibres end abruptly against the wall, so to speak.

The commercial asbestos is of the first type mentioned, and is also found as veins occurring in fractures, cracks, or joints planes cutting the massive serpentine, or the altered peridotite. The fibres stand at right angles to the wall, so that

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[11] Ont. Bur. Mines, Vol. XXIV, 1915, Part 3.
[12] Ibid., Vol. XXIII, 1914, Part I, pp. 47, 48.
[13] Ibid., Vol. XXIV, 1915, Part 1, pp. 171-184.
[14] Ibid., Vol. XVIII, 1909, Part 1, pp. 273, 274.

all the asbestos is placed into the veins exactly as were the microscopic fibres in the individual crystals of olivine. The veins vary in width up to two and a half inches, and are abundantly scattered through the rock, with a good deal of parallelism in the main, but with many cross veins, and even horizontal ones in addition.

These veins of asbestos form in places as much as 12 per cent. of the rock mass, so that it is practically impossible that they represent the filling of open fissures. So large a number of spaces up to two and a half inches in width, running in all directions through the mass, could scarcely exist as actual openings. The writer therefore believes that they represent the numerous fractures that would result partly from the original cooling and shrinkage of the rock mass, but mostly from the increase in bulk of the rock while undergoing serpentization. These fractures would not be open ones with walls apart, but merely cracks with walls practically in contact. As the sepentinization proceeded all through the rock, those portions actually along the cracks would behave in the same way as the microscope shows the olivine to have behaved along the cleavage and fractures within the individual crystals of it in the rock. Re-crystallization of the serpentine along the cracks therefore took place, and extended at times an inch or more into each wall from the crack, and the original break is now represented by a medial plane which is found through almost every asbestos vein.

One of the most striking features of these asbestos veins is the uniformity of width which they maintain. That is to say, while all variations in width are found among the several veins, from mere stringers up to two and a half inches, yet one and the same vein preserves a remarkable constancy of width. They are little dike-like bodies, whose walls are parallel, the asbestos ending so abruptly against the wall rock as to suggest no connection whatever with it. The writer believes that the asbestos veins, although distinct and dike-like in their appearance, are merely a phase of the re-crystallization that accompanied the alteration from olivine to fibrous serpentine; and that the solutions which brought about the change seeped along a crack or fracture and attacked both walls simultaneously, and worked out to about the same distance in each wall, thereby producing veins of very even width, and uniformity of texture.

That the serpentine is dense in one place, radial in another, or in felt-like intergrowths, or fibrous in still other places, is probably due to the differential pressures throughout the peridotite mass, due to the expansion in volume which accompanied the change from olivine to serpentine. This expansion can be shown by calculation of the molecular volumes of the olivine and serpentine, to be as high as 50 per cent. or even more in certain cases.

The best deposit seen by the writer is known as the Campsell claim H.R. 968, in the township of Deloro, which is reached by a good road from South Porcupine. Portions of the serpentine on this claim carry as high as 12 per cent. of asbestos veins, and fibre is found up to two and a half inches in length, much of it being two inches. The writer learns that since his visit to this claim it has been opened up and shipments[15] of asbestos have been made.

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[15] See page 167, Mines of Ontario.

MOLYBDENITE DEPOSITS OF ONTARIO

By A. L. PARSONS

Introduction

In accordance with instructions from T. W. Gibson, Deputy Minister of Mines, the writer undertook the investigation of the molybdenite deposits of Ontario during the months of May, June and September, 1916. In this work an effort was made to visit every producing locality, and nearly every known prospect in the eastern part of the province was examined. In a few instances where previous descriptions indicated that deposits were of no commercial value, recorded localities were not visited, but in every such case information was received from men who had investigated the deposits which confirmed the previously published descriptions. Although it was known that there are many occurrences of this mineral in the western part of the province, some of which had been seen by the writer a few years ago, it did not seem desirable to extend the work in this direction, as the known deposits that have been described are in nearly all cases too small and too poor in molybdenite to be of economic importance. It was, however, deemed advisable that the deposit on Gull lake, near Dryden, should be examined and E. Thomson was instructed to visit this property. Another property in the Manitou lake region was also visited by Mr. Thomson; and the descriptions of these occurrences are included in this report.

In the investigation, a feature of prime importance was the ascertaining of the common mode of occurrence of the mineral, as a guide to prospecting for further economic deposits. There seemed to be particular need of this, as the common association of molybdenite in eastern Ontario is such that a person reading the ordinary descriptions of the occurrence of this mineral would be likely to look in almost any other place than where it is most likely to occur. Dr. T. L. Walker has given a brief description of this type of occurrence,[1] and has indicated it as being typical. In view, however, of the almost universal generalizations that are ordinarily given, it is desirable to emphasize the statement that nearly every deposit of commercial importance in eastern Ontario is at or near the contact of granitic rock and crystalline limestone.

An attempt was also made to get an estimate of the quantity of molybdenite available in the various mines and prospects. This, however, is an extremely difficult matter in most cases for two reasons: first, because the rich specimens have usually been taken away, so that the stock piles and dumps consist of low grade material; and second, the weathering of the rock and ore exposed in the mine results in the oxidation of the molybdenite to molybdite, which is usually worn away from the exposed surface.

[1] Mines Branch Bull. 93, Molybdenum Ores of Canada, p. 9.

Molybdenum Minerals

In studying the possibility of increasing the production of molybdenum, it is of interest to tabulate the known minerals which contain this metal, and to consider the chemical and physical properties of each, as well as the mineral association. In certain cases this may lead to the discovery of other substances of considerable economic importance. The known natural compounds of molybdenum are the following:

Molybdenite	MoS_2
Molybdite	$Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$
Ilsemannite	$MoO_2.4MoO_3$
Wulfenite	$PbMoO_4$
Powellite	$CaMoO_4$
Belonesite	$MgMoO_4$
Achrematite	$3(3\,Pb_3As_2O_8.\,Pb.\,Cl_2)\,1(Pb_2MoO_5)$
Koechlinite	$Bi_2O_3.MoO_3$
Pateraite	
Eosite	
Molybdosodalite	

Molybdenite is the commonest ore of molybdenum, and at present the only one found in Ontario in economic quantities. It looks much like graphite, and occurs in scales which are sometimes so minute as to require a microscope for their detection, while at other times the scaly masses may be as much as a foot in diameter. Occasionally these scales radiate from a common centre forming nodules, while at times the aggregate may have an earthy texture. In all cases, however, the mineral exhibits a colour which may be used to distinguish it from graphite, the only mineral with which it is likely to be confused. The colour is a bluish lead gray, while graphite is black to brownish black. If, however, the colour does not serve as a distinguishing feature, it is easily tested by making a mark with it upon paper. Usually this mark is shining and of a bluish colour, because the powdered mineral is not finely pulverized. If, however, this mark is rubbed with the finger, the paper and finger pulverize it still finer, and it becomes grayish green. No other mineral which will make a mark on paper will yield this colour. Although so extremely soft, it is decidedly heavy (sp. g. 4.7), and its greater specific gravity might also be used to distinguish it from graphite.

Molybdite is a straw-yellow to canary-yellow mineral, which is frequently found near the surface as a result of the oxidation of molybdenite. It was formerly supposed to be pure molybdic acid, but recent investigations by Schaller show it to be a hydrous ferric molybdate. It is occasionally found in sufficient quantity to be useful as an ore, but at present it is doubtful whether this mineral can be recovered from Ontario ores economically.

Wulfenite is probably the second most important ore of molybdenum. It is usually honey yellow to orange red in colour, is easily scratched with a knife (hardness 3) but not by the finger nail, has a specific gravity of about 7, and occurs in thin tabular crystals. Occasionally the crystals develop a pyramidal habit. It occurs in considerable abundance in Arizona, New Mexico, Nevada and California. It is found principally near the surface along with other oxidized ores of lead.

In view of the large deposits of this mineral, it would be natural to expect to find the sulphides of lead and molybdenum intimately associated. This, so far as the writer has observed, is not the case, but it is of interest to note that lead deposits are found in certain parts of eastern Ontario, not far from molybdenum-producing localities. Whether these deposits belong to the same period of ore deposition as the molybdenite is an unsolved question, but if they do it is possible that a mineral containing both lead and molybdenum would occur at a certain depth.

Koechlinite is a mineral which has recently been described by Schaller.[8] It occurs in small greenish tabular crystals resembling torbernite, and is associated with quartz, native bismuth, smaltite, a red mineral (realgar?), a few needle-like prisms of a gray metallic mineral (bismuthinite?) (stibnite?), and three unidentified minerals. The original material came from Schneeberg, Saxony. In composition it is a molybdate of bismuth (Bi_2O_3. MoO_3.) Two points of interest are to be borne in mind. The association is the Cobalt silver association, and so indicates the possibility of the existence of this mineral in Ontario. The possiblity of a similar mineral containing sulphur instead of oxygen at greater depth is to be considered. The association of molybdenite and bismuthinite is common, and it is desirable to examine such deposits carefully for unknown minerals.

Belonesite is a substance crystallizing in small needle-like crystals in one of the lava flows at Vesuvius. From qualitative tests it was shown to contain magnesia and molybdic acid.

Powellite is a rare mineral found at the Peacock lode in the Seven Devils mining district in Idaho. It consists principally of calcium molybdate, but contains in addition some calcium tungstate.

Achrematite is a massive material found in the mines of Guanaceré, Chihuahua, Mexico. The composition corresponds to a mixture of mimetite, massicot and wulfenite.

Ilsemannite is a blue-black to black crypto-crystalline mineral, which becomes blue on exposure. It is soluble in water, giving a deep blue solution. It is a product of the decomposition of metallic molybdates. It is probably owing to the presence of this mineral, that pyrrhotite and pyrite when associated with molybdenite are tarnished so as to be readily mistaken for bornite and chalcopyrite.

Pateraite is a black massive mineral supposed to be a molybdate of cobalt from Joachimsthal. The material was so intimately mixed with pyrite and bismuthinite that it could not be completely separated and the exact composition is unknown.

Eosite from micro-chemical tests is assumed to be a vanado-molybdate of lead.

Molybdosodalite is a variety of sodalite from Monte Somma which contains over 2 per cent. molybdenum trioxide.

So far as the Ontario deposits are concerned, the only one of the minerals enumerated above that is of importance is molybdenite, though in a few instances the molybdite is sufficiently prominent to suggest the possibility of economic recovery by leaching the ore with ammonia before further concentration.

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[8] U. S. Geol. Sur., Bull. 610, pp. 10-34.

A New Molybdenum Mineral

A dark green mineral rich in molybdenum occurring as an incrustation on specimens of ore from Lucania Tunnel near Idaho Springs, Colo., has recently been discovered by F. B. Laney of the United States Geological Survey.[1] The mineral itself has not yet been fully examined, but an analysis of the mine water, which is of a deep blue colour and has a specific gravity of 1.031 at 25° C., yields a high molybdenum content. This analysis shows in grams per litre:

Molybdenum trioxide (MoO_3)	7.98	Magnesium	.73
Molybdenum dioxide (MoO_2)	Trace	Sodium	.26
Ferrous Iron	2.01	Potassium	.14
Ferric Iron	1.75	Sulphate (SO_4)	18.26
Aluminium	.27	Chlorine (Cl)	.17
Calcium	.50	Hydrogen (of free acid)	.13

In addition to the minerals mentioned above, we have minerals of somewhat doubtful character, mentioned in various publications. Molybdurane is supposed to be a molybdate of uranium, and is said to be found at Joachimsthal, Bohemia. Knightite is said to be a phosphate of molybdenum, found at Catherine's Hill in the State of Maine. Molybdo-ferrite is said to be an anhydrous ferrous molybdate. The writer has been unable to find the original descriptions of these minerals. A source of molybdenum which may be of considerable value in certain regions is scheelite, the tungstate of lime. This mineral frequently contains molybdenum in place of part of the tungsten, and in certain instances the molybdic acid is more than 8 per cent. of the mineral. In connection with this it may be mentioned that in the analysis of powellite, the molybdate of lime, more than 10 per cent. of tungstic acid was found.

Geological and Mineralogical Association

The geological and mineralogical association of molybdenite vary materially in different mining regions, and a rule for prospecting which might be valuable in one region would be useless in another. In general, however, it may be said that it is found in or near granitic rocks, though it is seldom an original constituent of these rocks. The principal types of occurrence are:

(*a*) Pegmatite deposits, in which the molybdenite is associated principally with quartz and feldspar, with smaller quantities of mica and pyroxene.

(*b*) Quartz veins, which often carry, in addition to the molybdenite, ores of bismuth, tin and tungsten, and frequently tourmaline. Pyrite and pyrrhotite are also frequently found in these veins. Sometimes copper ores are also associated with the molybdenite, but in Ontario this is not common.

(*c*) Mineralized crevices in granitic rocks, where the molybdenite has been deposited on the walls, but the crevice has not been filled as in (*b*) with quartz or other vein matter. Such deposits are frequently very showy, but are of little economic value.

(*d*) "Pipes" of silicious material in granite, carrying molybdenite and bismuth, such as the deposits at Kingsgate near Glen Innes, New South Wales, and Wolfram Camp, Queensland.

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[1] U. S. Bur. Mines, Bull. 111, p. 15.

(*e*) Biotite granite carrying molybdenite as an original constituent, is described from Mt. Stronach, near Scottsdale, Tasmania.

(*f*) Contact deposits at or near the contact of granite and other rocks. These, so far as our knowledge goes, are by far the most important of the deposits in eastern Ontario, and possibly of western Ontario as well. In general, they lie at the contact of granite or pegmatite with crystalline limestone in a zone of pyroxenite, which has presumably been formed by the metamorphic action of the granite mass upon the limestone. In these deposits pyrite and pyrrhotite are almost universally present, while the other associated minerals are quartz, calcite, tourmaline, phlogopite, titanite and hornblende.

A variation from the type of contact deposit common in Ontario occurs at Tasmania, where the ore on King Island is said to consist essentially of garnet with quartz, epidote, calcite, monoclinic pyroxene and actinolite. The metallic minerals are scheelite, molybdenite, pyrite and bismuth. This deposit is very close to a contact with granite, and probably represents a more highly metamorphosed type than most of the Ontario deposits.[1]

Prospecting for Molybdenite

So far as the deposits in eastern Ontario may be used as a guide in prospecting for further deposits of an economic character, the most favourable locations are near the borders of granite masses, particularly when these are in contact with crystalline limestone. In case a band of pyroxenite is found between these two rocks, this should be thoroughly examined for molybdenite, as in all the deposits that the writer has examined pyroxene has been associated with molybdenite. As to the conditions in the western part of the province where limestones are almost lacking, it is probable that the molybdenite, when found, will be near the contact of granite and the basic igneous rocks. In the few instances where the writer has seen deposits of molybdenite in the western part of the province, this is the case, but he has not seen a sufficient number to warrant him in stating definitely that it is the rule.

Concentration

Hitherto the concentration of molybdenite has been one of the most difficult problems in ore dressing. This has been due in part to the high molybdenum content demanded by the market, and in part to the character of the mineral. For ores which contain no bismuth or copper the standard of the market is too high for the best interests of the industry, as the demand is for a concentrate that will carry from 90 to 95 per cent. MoS_2. In the case of the ores from eastern Ontario as well as other ores which the writer has seen, it would be more equitable to base quotations on a 70 per cent. concentrate. The impurities in these concentrates are either sulphides or silicates, principally pyrite and pyrrhotite, or pyroxene and mica. In use, the concentrate is either introduced as the sulphide into the furnace, or roasted to convert the molybdenite to molybdic acid. In the first case, pyroxene and mica would be removed in the slag, while the pyrite and pyrrhotite would furnish a source of iron for the manufacture of ferro-molybdenum.

[1] Geological Survey of Tasmania, Mineral Resources, No. 1, Part III, page 10.

In that case the value of the concentrate should be based on the molybdenite content, and the iron values should be added.

In case the molybdenite is to be roasted, these accompanying minerals are of no value, but are also harmless, and are removed with little difficulty in the subsequent leaching of the roasted mass.

As a preliminary to further treatment of the ores, it is customary to pick out by hand large flakes, as the loss in crushing, rolling and screening of this type of material is comparatively large. In all concentrating mills the ore is reduced to a size that will pass a 20-mesh screen. Extremely fine grinding is not to be desired in most cases, as that portion of the rolled material which passes through a 60-mesh screen is found to carry an almost negligible quantity of molybdenite. In consequence, the best results will probably be obtained by crushing and rolling the ore to pass a 20-mesh sieve, and passing this material over a 60-mesh screen to remove dust, thereby lessening the load on the concentrator.

The various concentrating machines will be discussed in the description of the several plants. Detailed descriptions of well known concentrators are not given, except where some new feature has been introduced for the treatment of molybdenite.

Spain Mill

This mill is owned by Mr. W. J. Spain of New York, and is located at the Spain mine in Griffith township, Renfrew county. A general view of the principal buildings is given in figure 1.

The power is furnished by two 60-h.p. boilers which are located in the building to the left. The engine is in the mill building. Before being brought to the mill, the large flakes of molybdenite are picked out by hand, and the rock containing the smaller material is then put through a jaw crusher. From this point it is carried on a picking belt, where flake molybdenite and waste rock are removed, to a set of rolls which reduce it to about ½ inch. It is then conveyed on a second picking belt to a second series of rolls. The fine material is then dried in a steam drier and bolted, after which it is further concentrated by a Hooper pneumatic concentrator. This represents the practice in the early part of the summer. During the summer, however, a modification was introduced in the form of a Wood's machine.

Renfrew Molybdenum Mines, Limited

This company's mill was in course of construction during the summer, and was not finished at the time of the writer's second visit in September. The manager, Mr. Charles Spearman, however, kindly furnished some particulars of the proposed method of concentration. It is the intention to use the Elmore Vacuum concentrator, and as a preliminary to concentration the ore is crushed and put through a ball mill to reduce everything to a fine state. These fines are then mixed with a certain amount of oil and put through the concentrator, whereby the sulphides are removed as heads, while the remainder of the rock material goes off as tails. The writer did not receive details as to the further treatment for separating molybdenite from the other sulphides. This process is said to be very successful in the treatment of Swedish molybdenite ores.

The accompanying view of the molybdenite deposits of this company shows the boilers and compressor in process of installation. The boiler house was completed, and most of the frame-work for the concentrating plan had been erected, at the time of the writer's second visit in September.

Fig. 1—Buildings at the Spain mine.

Fig. 2—View of outcrop at Renfrew Molybdenum mines.

International Molybdenum Company

The preliminary work of this company in the concentration of molybdenum ores was carried on at their plant in Orillia, but as the concentrating machinery was moved during the summer to their new plant at Renfrew, a detailed description of the latter only will be given.

The ore is first put through a gyratory crusher, which reduces it to an inch mesh, and is then elevated to large rolls. The product of the rolls is screened, and the oversize returned to the large rolls, while that portion of the remainder which will not pass a 20-mesh screen is passed through a second set of rolls, the oversize being returned to these. The pulverized ore is then taken to a concentrator which was devised by the manager, G. P. Grant, a description of which follows.

The concentrator consists of a long wooden vat about 12 feet long in which a series of boards or baffles is placed at right angles to the direction of flow of the water. Several types of feed have been tried, two of which have proven more successful than the others. For very fine material, a gentle blast of air blows the ore over the surface of the water and as the current of water carries this material over the baffles the surface tension is altered, so that the more angular pieces sink while the flaky material remains on the surface. The material thus floated is received in a tub provided with a screen which permits the water to escape, while the concentrate is retained. This concentrate is then dried on a steam coil. For coarser material, the distribution on the surface of the water is accomplished by a rotating drum covered with cloth, the material being distributed on the drum by a conical feed. The larger fragments sink before reaching the first baffle plate, so that this material is screened to recover large flakes of molybdenite. The rest of the operation is the same as that described above. From this concentrator it is usual to get a product running from 65 to 80 per cent. MoS_2 without further treatment. In case a higher grade is desired, the product is cleaned by screening the finely rolled material, which removes the more angular fragments of pyrite and quartz that may have come over, while saving the flaky molybdenite. No acids or oils are used in the concentration, the principal pre-requisite to the successful concentration being that the material shall be dry.

Mines Branch, Ottawa

A large portion of the testing plant of the Mines Branch, Mines Department, has been devoted during the past year or more to the concentration of molybdenite. Through the courtesy of the Director, Dr. Eugene Haanel, the writer was permitted to examine the plant. The general plan of procedure is to crush the ore in a jaw crusher, after which it is passed through rolls. At the time of the writer's visit a ball mill was being installed for finer grinding. The finely pulverized material is fed to a modification of the Woods flotation machine, but since the writer's visit the operation has been considerably changed, and wet crushing is now possible. At the time of his visit, the ore was fed to the surface of the water by means of an endless apron, and the gangue sank, while the molybdenite remained floating. With the molybdenite a considerable quantity of pyrite and other minerals continued to float, and this was then taken on another apron and re-deposited on the surface of the water. The portion that still floated was drawn off as concentrate. This was further treated by being dried and re-floated so as to remove the iron sulphides which were the principal impurities in the molybdenite after passing over the concentrator. In the modified machine which was described by G. C. Mackenzie before the Royal Canadian Institute, the endless aprons have

been removed, and the ore is fed directly on to the surface of the water, and the breaking of the surface tension is brought about by jets of water from below the surface.

Uses of Molybdenum

The uses for which molybdenum is employed are more numerous than would at first be thought. Of first importance is its use when alloyed with iron to make molybdenum steel. This is an extremely hard alloy, which retains its hardness to a remarkable degree, even when raised to a dull red heat. It is employed as a high speed steel for lathe work, and is also said to be used for rifle barrels and the cores of large guns.

In the chemical industry, large quantities of molybdic acid and ammonium molybdate are employed in the determination of phosphoric acid. Various molybdenum compounds are employed for dyeing fabrics, colouring leather and rubber, and porcelain painting. Certain compounds are said to be used for fireproofing cloth.

The method of preparation of many of the compounds is secret, and depends upon making them at certain temperatures and with other conditions carefully adjusted. This is shown most strikingly in the preparation of molybdic acid, which may be obtained in a crystallized state by observing proper precautions, while the neglect of these precautions gives rise to the production of a chalky mass of a much lower grade of purity.

Among minor uses for which molybdenum or molybdenum compounds are employed the following may be mentioned:

The metal is employed in the electric resistance furnace in place of platinum because it is not only cheaper but gives quicker heat, and higher temperatures are attainable. For this purpose, however, the molybdenum must be protected from the air, as at high temperatures it is attacked by oxygen.

In the incandescent electric lamps, the supports for the filaments are made of metallic molybdenum.

In certain contact making and breaking devices, molybdenum is used as a substitute for platinum and platin-iridium.

In the Coolidge X-ray tube a considerable proportion of ductile molybdenum is employed.

In dentistry it is stated that molybdenum wire covered with gold is utilized to some extent.

A molybdenum-tungsten thermo couple has been recommended for measuring high temperatures.

It is said that molybdenum is employed in some form for the preservation of cordite in hot climates, but no definite information on this subject appears to have been published. It is also affirmed that molybdenum is used in the synthetic preparation of ammonia under processes covered by German patents. Several alloys of considerable interest and possibly of prime importance of molybdenum with other metals are known. Among these may be mentioned molybdenum-nickel, molybdenum-chrome and molybdenum-stellite, the last mentioned being composed principally of molybdenum, cobalt, chromium and iron.

Fig. 3—Partial view of plant of the International Molybdenum Company at Orillia.

Fig. 4—Electric furnace making ferro-molybdenum,
International Molybdenum Co., Orillia.

The artificial compounds of molybdenum are so numerous that it is not [illegible] able to make a list of them at this place, but for an extended description of these the reader is referred to an excellent description of the substances by Moissan.[5]

Ferro-Molybdenum Industry

Two firms in Ontario have undertaken the manufacture of ferro-molybdenum during the past year, The International Molybdenum Company and the Tivani Electric Steel Company. In the early stages of the work both companies encountered serious difficulties, but with more complete knowledge of the physical and chemical conditions necessary for the proper reactions, these difficulties have disappeared, and both companies are now steady producers. Apart from the purely technical difficulties, the industry was seriously hampered by the scarcity of suitable refractory material for the furnaces, and at one time it was difficult to secure suitable electrodes.

The International Molybdenum Company made an experimental run on a laboratory scale at their Orillia plant on May 8th, 1916, and secured a small quantity of beautiful ferro-molybdenum. This product consisted of tabular crystals and a fine granular mass, and while the main mass ran over 70 per cent. Mo, it was stated by G. P. Grant that the tabular crystals contained about 52 per cent. Mo. This latter would probably be equivalent to Fe_3Mo_2 which would contain 53.3 per cent. Mo and 16.7 Fe. In September the company began work on a commercial scale. The furnace is a single arc tapping type, as seen in Fig. 1. The capacity of the original furnace as shown was about one hundred and twenty-five pounds. In the earlier runs pure molybdic acid was mixed with iron, flux and coke. Later runs were made with roasted concentrates, which in some cases still carried sulphur. The resulting ferro-molybdenum in both cases was practically free from sulphur, as this is volatilized in the intense heat of the arc, or is in part taken up by the slag.

The Tivani Electric Steel Company, Limited, of Belleville, have been making ferro-molybdenum since September, 1916. At the time of the writer's visit a charge was being treated in a triple arc Evans-Stansfield furnace which is illustrated in figure 5. As will be noticed, this is a large furnace and is easily manipulated. The charge is introduced through the door at the side, and the slag and molten metal are poured by tilting the furnace and allowing the molten material to flow out of the spout just above the man's head. A smaller two-arc tapping furnace was used for an earlier run and is shown in figure 6. This company has been shipping ferro-molybdenum steadily during the autumn. The charge that was being treated at the time of the writer's visit was composed of molybdenite, with the proper addition of iron and flux. The sulphur in the molybdenite was practically all taken up by the slag, or converted into sulphur dioxide, so that the resulting ferro-molybdenum was practically free from sulphur. As a result of this, the writer has recommended in another part of this report that the grade of molybdenite concentrates should not exceed 70 per cent. when pyrite and pyrrhotite are the only impurities, as these will furnish the necessary iron for the alloy, with a saving in cost of concentration. The first run from this furnace yielded about one hundred pounds of ferro-molybdenum.

[5] H. Moissan, Traits de Chimie Minerale, 1905, T. IV, 685-758.

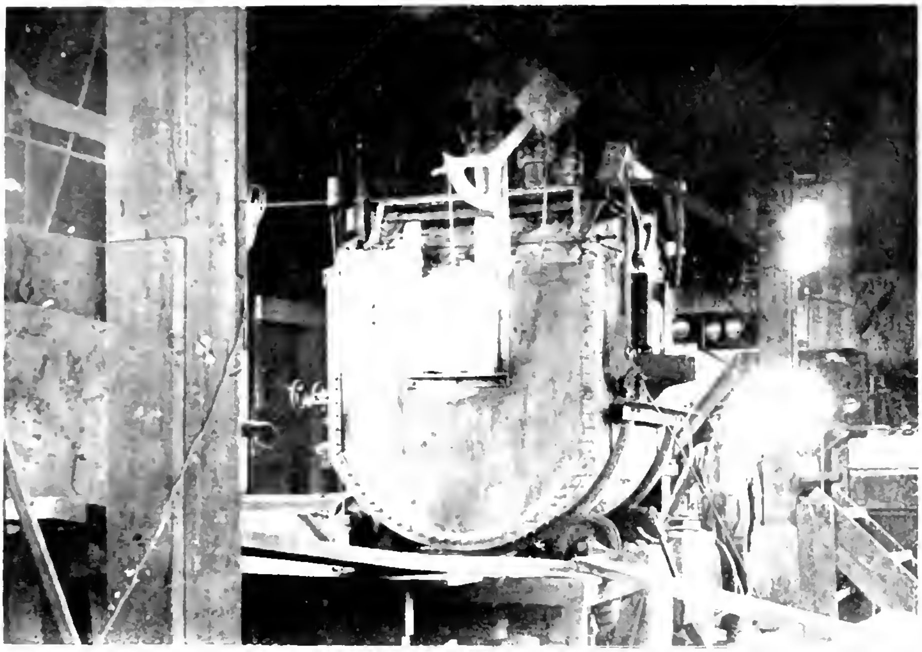


Fig. 5.—Electric furnace making ferro-molybdenum, Tivani Electric Steel Co., Belleville.

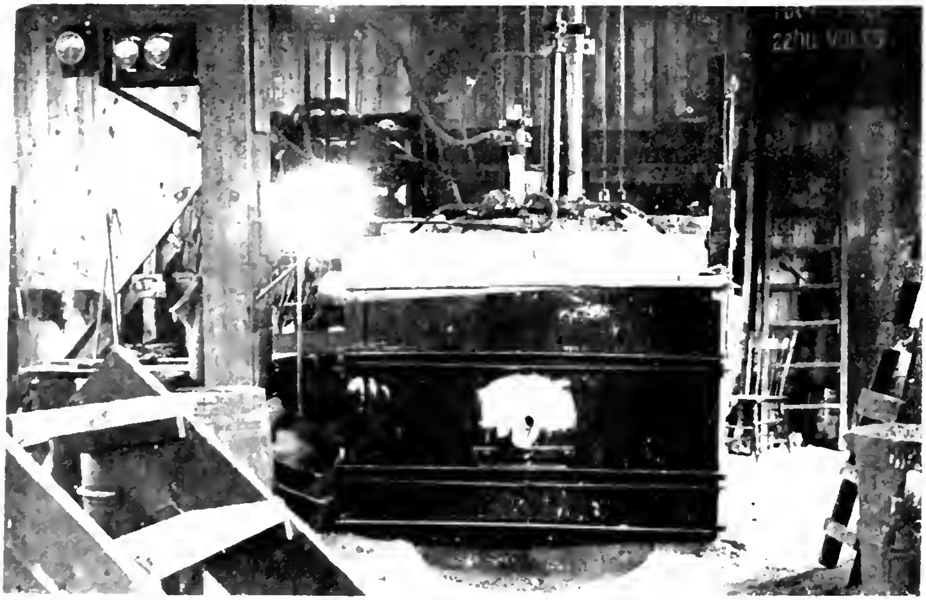


Fig. 6.—Electric furnace, Tivani Electric Steel Co., Belleville.

Ontario Mines and Deposits

The molybdenum deposits of Ontario are very numerous, and with the prospecting that has been carried on the list may undoubtedly be greatly extended. The mineral occurs in nearly all parts of the Province where pre-Cambrian rocks are found. In the description the various occurrences have been taken up alphabetically according to the townships in which they are located. The following summary by counties and districts will serve to indicate in a brief manner the general distribution, which is also shown on the sketch maps accompanying the report:

ADDINGTON COUNTY; Sheffield township.
ALGOMA DISTRICT; Molybdenite lake.
CARLETON COUNTY; March township.
FRONTENAC COUNTY; Miller and Olden townships.
HALIBURTON COUNTY; townships of Cardiff, Harcourt and Monmouth.
HASTINGS COUNTY; townships of Carlow, Dungannon and Monteagle.
KENORA DISTRICT; Gull lake, Ignace, Lake of the Woods, Lac Seul, Maniton lake, Smooth Rock lake and Wabigoon lake.
LEEDS COUNTY; North Crosby township.
MUSKOKA DISTRICT; Monck township.
DISTRICT OF NIPISSING; townships of Airy and Roberts, and near Talon Chute (not molybdenite).
PETERBOROUGH COUNTY; townships of Anstruther and Belmont.
PARRY SOUND DISTRICT; Foley township.
RAINY RIVER DISTRICT; Rainy lake and Steep Rock lake.
RENFREW COUNTY; townships of Bagot, Blithfield, Bromley, Brougham, Griffith, Lyndoch, Matawatchan, Raglan, Roberts, Ross and Sebastopol.
SUDBURY DISTRICT; townships of Denison, Garrow, Graham and Drury (Worthington mine).
THUNDER BAY DISTRICT; Big Duck lake, Conmee township, Terrace Cove (Black River), (Seabeach Bay), Longuelac, and Tamarack lake.
TIMISKAMING DISTRICT; Beatty township, Kirkland lake, Net lake, Porcupine and Swastika.

In the description of the deposits of molybdenite every known locality is mentioned. Where it is definitely known that any deposit is not of an economic character, it is so stated. In many cases, however, a deposit which is at present not economic, may with further development become a very desirable property. When the writer has not seen a property, he has given the best opinion available in regard to the deposit with the authority for the opinion.

Anstruther Township

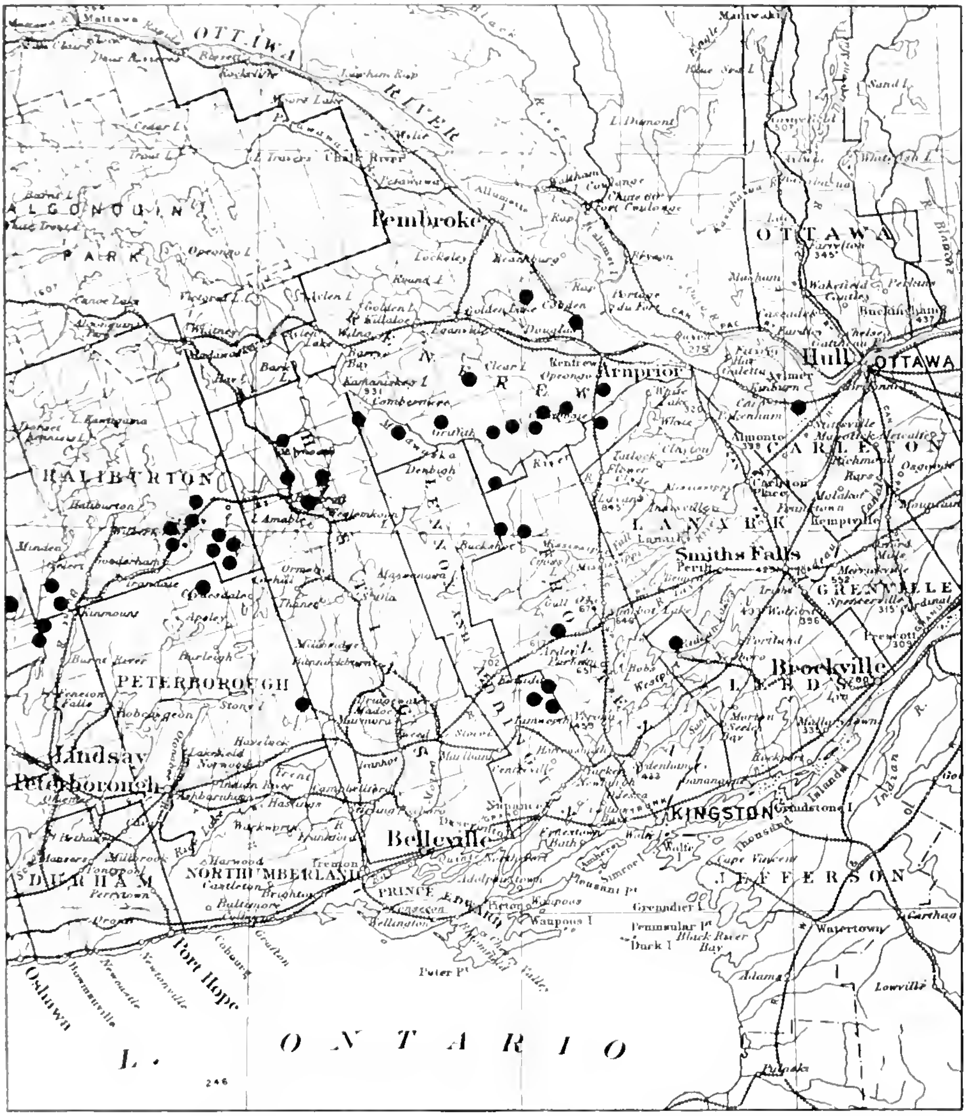
Molybdenite is reported from lot 24 or 25, concession XIV,[6] but so far as the writer has been able to ascertain no development work has ever been done here. The locality is close to the contact between crystalline limestone and gneissoid granite, and should be further prospected.

Airy Township

District of Nipissing. Molybdenite was reported from two locations near the boundary of the Algonquin Provincial Park. One of these was visited by the writer, and it was found that the material was graphite rather than molybdenite. Unfortunately, the gentleman who showed this property did not know the location

[6] Ont. Bur. Mines Vol. XII, p. 56.

of the second reported occurrence, so that the writer was unable to examine it. He was, however, shown samples of molybdenite by G. W. Bartlett, Superintendent of the Park, which had come from some portion of the latter. As to the extent of the deposits, however, nothing was known.



Map of part of eastern Ontario, scale 35 miles to the inch, showing location of molybdenite deposits.

Bagot Township

On the farm of Samuel Hunter, lot 15, concession X, excavations were made several years ago for molybdenite. These pits are now overgrown with shrubbery, but were dry so that they could be examined. The principal pit is about 5 feet

wide and about 15 feet long, and is sunk on a pyroxenite pegmatite dike in crystalline limestone. The molybdenite-bearing portion is about a foot wide, and carries also some pyrite and tourmaline. The specimens seen, however, were decidedly lean, and the deposit does not appear to be of economic value.

On lot 28, concession XII, on the farm of John Culhane, development work has been done by R. R. Gamey, M.P.P. The principal pit is about 10 by 8 by 4 feet. Mr. Culhane informed the writer that about 200 pounds of flake molybdenite was taken out. There was still to be seen on the dumps possibly a ton of concentrating ore, and a few pounds of flake molybdenite which had been laid aside in tins.

On the farm of William Warren, lot 27, concession IV, considerable development work has been done by Mark J. Paterson and Sir Henry Pellatt. At the time of the writer's visit, however, the pits were filled with water, and the molybdenum-bearing rock was seen only in the stock piles. About four tons of concentrating ore was seen. The writer has since been informed that additional material was stored in barrels.

Lot 25, concession IV. Mr. Morin of Springtown showed samples of molybdenite, which he said came from his farm on the above location. Only one shot had been put in. Conditions were such that Mr. Morin could not take the writer to the place without considerable delay, so that this location was not seen. The samples, however, were of the typical molybdenite-pyrrhotite-pyroxenite association.

Beatty Township

On the Abate claim, lot 1, concession I, P. E. Hopkins reports the presence of molybdenite in a gold quartz vein.[7] The molybdenite is, however, not present in economic quantities.

Belmont Township

"Edward Shannon reported molybdenite from Peterborough county not far from Cordova Mines."[8] No further information is available in regard to this occurrence.

Big Duck Lake

In reporting on the gold deposits of Big Duck lake north of Schreiber, P. E. Hopkins says: "Much pyrite, chalcopyrite, and some pyrrhotite, galena, zinc blende, magnetite and molybdenite (?) are disseminated through the veins."[9] This is the only record that the writer has found of an association of molybdenite and galena, and as its presence was questioned by Mr. Hopkins, it is evident that molybdenite is not present in paying quantities, if at all.

Black River, Lake Superior Region

This is undoubtedly the same as the Terrace Cove locality.

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[7] Ont. Bur. Mines, Vol. XXIV, Pt. I, p. 180.
[8] Ont. Bur. Mines., Vol. XII, p. 57.
[9] Ont. Bur. Mines, Vol. XXIV, Pt. I, p. 11.

Blithfield Township

On the farm of Thomas Quilty, east half of lot 29, concession I, of Blithfield, six pits have been opened up along the contact of granite and limestone, resulting in the prospecting of about 400 feet of contact. The property was examined by a company which contemplated entering upon the production of ferro-molybdenum, and the writer's information was obtained from the company's engineer. The width of the mineralized contact zone is said to be about 15 feet, and the chief mineralization seems to be on the side toward the limestone. Among the associated minerals are pyrite and pyrrhotite, and the flakes of molybdenite reach 1 inch in diameter. The mineralization is somewhat irregular.

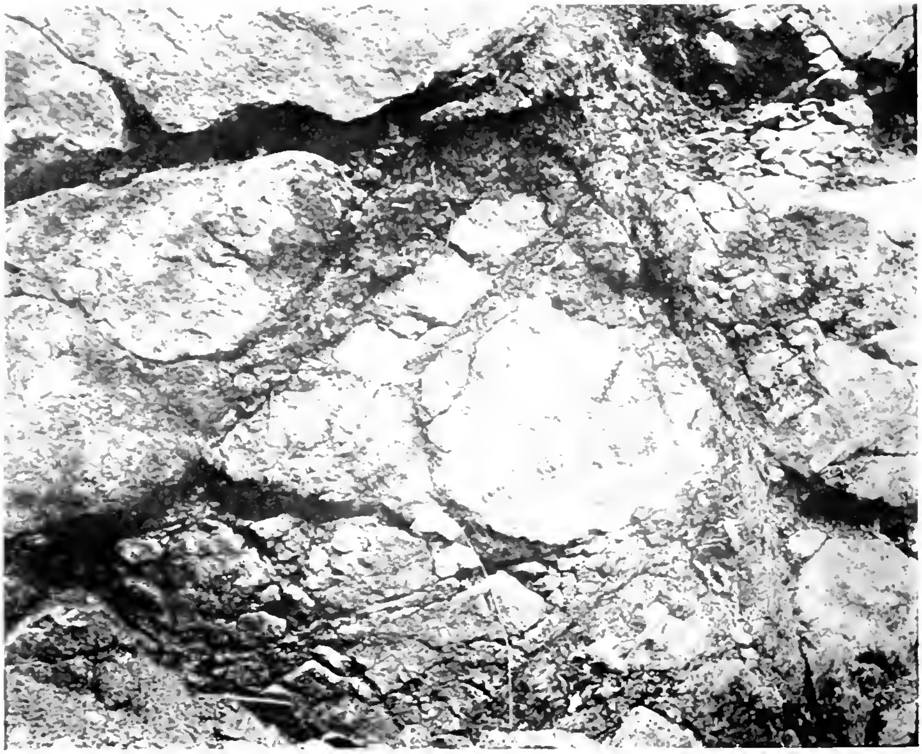

Fig. 7 Pyroxenite carrying molybdenite, Legree mine, Brougham township.

Bromley Township

On the northwest half of lot 24, concession V, Bromley township, a deposit of molybdenite was opened during the early summer by J. E. Cole, lessee. The molybdenite is in a pyroxenite mass, and was seen at intervals for a distance of about 400 feet. Pegmatite is not prominent in the pits, but is associated with the pyroxenite, and comprises about half of the visible rock on one of the dumps. So far as development had gone, the property was low grade, but a consignment of 1½ tons of 1 per cent. ore had been shipped to the Mines Branch for a test.

Brougham Township

On lots 35 and 36, concession XIV, Legree Brothers of Dacre, have opened up a deposit of molybdenite of considerable promise. The ore body consists of a micaceous pyroxenite in gneiss. Two open cuts have been made, one on each side of a roadway. These are about 10 feet wide, and vary in depth from three to ten feet. The total length is about 70 feet. Two stock piles of concentrating ore were kept separate from the rock, and several hundred pounds of nearly pure flake was laid on one side. The writer estimated that there was about 8 tons of 3 per cent. ore in the stock piles, and about 300 pounds of the

Fig. 8.—Part of ore body, Renfrew Molybdenum Mines, Brougham township.

flake. This, however, can only be considered an approximation. The property should be further developed, as this material is from the decomposed surface, and molybdite was very prominent both in the concentrating ore and in the flake. The accompanying illustration, figure 7, shows the spheroidal weathering of the ore body.

On lots 7, 8 and 9, concession XI and lot 8, concession XII of Brougham township, the Renfrew Molybdenum Mines, Limited, are engaged in mining molybdenite. The principal work is on lot 8, concession XI, on what is known as the Hunt property, and the Belgian property, the Renfrew Molybdenum Mines,

[illegible] the [illegible] Development Company. On the occasion of the writer's first visit to the property, preparations were being made to sink a shaft and put in a concentrating plant. A tunnel and cross-cut had been made in the deposit, and some diamond drilling had been done, while considerable ore had been taken from pits along the outcrop of the deposit. The molybdenite occurs associated with pyrite and pyrrhotite in pyroxenite, near the contact of the crystalline limestone and pegmatite, which has developed the peculiar structure known as graphic granite. At the time of the second visit in September a 7 by 11 foot shaft had been sunk 71 feet, and two stations made, so that a better idea of the character of the deposit was obtained. The width of the latter is not so great as appears on the surface, but is still sufficient to make a very good working body. In certain portions of the shaft, the crystalline limestone was found on both sides of the pyroxenite. The ore body has been traced on the surface for a length of about 400 feet, and at one point it is known to reach a depth of 100 feet. The general character of the pyroxenite ore body is shown in the accompanying illustration, figure 8, which shows about half the width of the ore body at this point. The richer portion of the pyroxenite is from 10 to 15 feet wide, and it is estimated that it will run about 1 per cent. MoS_2. There is, however, much of the material that will run considerably higher, but with the more recent methods of concentration it is probably not desirable to cob the better part except in the case of large flakes. The ore is to be concentrated on the spot, and the method is described more fully elsewhere in this report.

A shipment of about 16 tons was concentrated at the testing plant of the Mines Branch at Ottawa in 1915. The calculated percentage of MoS_2 was 0.84.

On lots 16 and 17, concession XI, and lot 17, concession X, Brougham township, the International Molybdenum Company was engaged in the mining of molybdenite during the summer. On the occasion of the writer's first visit in June, the manager, J. C. Murray, informed the writer that over 300 tons of ore had been shipped. This ore ran about 2 per cent. MoS_2, and was shipped to Orillia, as the company had not at that time erected their plant in Renfrew. All of the work up to the first of June had been connected with pegmatitic veins in gneiss, and the ore had been taken out from surface workings. One of the deepest pits is shown in figure 9. Pyroxenite was not observed as a prominent feature round the workings at this time, but in September considerable work had been done in connection with a mass of pyroxenite near by. The principal opening on this pyroxenite was, however, on the west half of lot 16, concession XI, on what is known as the Morin property, which was being worked on option by F. G. Todd of Montreal.

The manager of both properties at this later visit was Dixon Wilder. The pyroxenite was being quarried, and the molybdenite-bearing portion was crushed and sacked for shipment with the equipment shown in figure 10. The ore was hauled to Ashdod station, and shipped to the International Molydbenum Company at Renfrew. The quarry face is about 30 feet broad, and the deposit shows on the surface for about 75 feet, when it apparently dips under the gneiss. A shaft 27 feet deep has been sunk near this outcrop, but is not utilized at present in the mining of the ore.

Fig. 9—Portion of the workings on lots 16 and 17, concession XI, Brougham township

Fig. 10—Crushing and sacking ore, Morin mine.

On the property worked by the International Molybdenum Company, two shafts were sunk during the summer. One of these was 40 feet deep, and was sunk in the hope of striking the extension of the pyroxenite on the Morin property. The other was 32 feet deep, and was sunk on a pegmatite vein in gneiss. At the bottom, limestone carrying some graphite was found, but not enough of the latter to warrant mining. The presence of graphite may be looked upon as an encouraging sign, as in certain graphite mines molybdenite is found before the graphite is reached.

Molybdenite has also been found on lot 15, concession XI of Brougham township. These deposits are small, and little work has been done.

Cardiff Township

In Cardiff township there are numerous outcrops of molybdenite-bearing rock upon which development has been done. Most of these were visited by the writer, but the information gathered was rather meagre, as none of the properties were working, and water interfered with a satisfactory examination.

The most extensive work was done on lot 11, concession X or IX, on the farm of Alexander Evans. Here a 7 by 9 shaft had been sunk, and there was an open cut about 50 feet long. The rock was principally pyroxenite in gneiss, but very little molybdenite was seen, as the workings were full of water. A small mill containing a crusher and set of rolls was near the shaft, and although no information was available it would appear that the concentration consisted of crushing, rolling, and screening. Dr. Walker reports that the molybdenum-bearing portion of the rock was about one inch wide at the top of the shaft, and 20 inches wide at a depth of about 35 feet. He also states that the molybdenite occurs in large flakes.

On lot 12, concession XI, Messrs. Matthews and McMahon did some prospecting in gneiss carrying pyroxenite and pegmatite, but have discontinued work. Some of the flakes of molybdenite from this property are large, being about 6 inches in diameter, but the high grade material is not abundant. It is, however, desirable that a search be made in the vicinity of the finer grained contact phase of the pyroxenite, in which the molybdenite is likely to be more uniformly disseminated, though in fine scales.

On lot 18, concession IX, on the farm of John Mooney, molybdenite was observed in an outcrop of granite. The richer portion was about 5 feet wide, and possibly 40 feet long. No work had been done, but the molybdenite showed on the surface in scales up to one inch in diameter. It was reported late in the autumn that work had been begun on this property.

On lot 6, concession IX, on the farm of W. R. Kidd, is an open cut about 8 feet wide and 10 feet deep at the deepest portion, by about 40 feet long. The country rock is gneiss, in which there are two parallel granitoid pegmatite veins, each about a foot wide, which carry molybdenite in flakes up to an inch or more in diameter.

On lot 11, concession V, on another farm belonging to Mr. Kidd, is a similar deposit upon which a trench about 50 feet long, from 3 to 8 feet wide and 4 to 8 feet deep, has been excavated. The pegmatitic portion is in two bands, six

inches and two feet wide respectively. The ore is low grade, but easily concentrated, as the flakes are large. Mr. Kidd reported that 100 pounds of flake molybdenite was taken from this trench.

Carlow Township

In the very fine fissures, thin splashes of molybdenite (running high in molybdenum sulphide) are found, but this ore does not occur in any quantity, enough for samples only. It is stated that there is a vein of molybdenite in the neighbourhood."[10]

Conmee Township

The following description of a molybdenite property in Conmee township is given by A. H. A. Robinson[11]:

A mile or so west of Hume station, on the Canadian Northern railway, on the southwest quarter of the south half of lot 13, concession III, in Conmee township, a 50-foot shaft has been sunk on an outcropping of molybdenite ore. The molybdenite is found associated with quartz in a vein striking a little north of east and traversing a dike of syenite porphyry which, in turn, cuts the green schists of the district. It is disseminated through the quartz, and sometimes the adjacent wall rock, in fine flakes and films. A little calcite also occurs with it in the vein, while iron, and possibly copper pyrites, is found disseminated in small quantities through both vein and wall rock, though more abundant in the latter.

As the shaft was full of water, and the neighboring country is drift covered, it was not possible to determine the extent of the deposit. Some seven or eight hundred feet or more to the east of the shaft, however, the porphyry dike and the quartz vein, here carrying a few scattered flakes of molybdenite, is again exposed in a small outcrop.

Digby Township

Molybdenite is reported by F. D. Adams on lot 16, concession VII,[12] but the quantity is too small to be of commercial importance.

Dungannon Township

Molybdenite is said to occur on lots 25, concessions XIII and XIV.[13] The writer visited this locality but was unable to find molybdenite, and so far as he could ascertain there had been no recent development work on these properties.

Foley Township

Small quantities of molybdenite, associated with pyrite, chalcopyrite and pyrrhotite, were found on the Big Four property, lots 32 and 33, concession V of Foley, Parry Sound district.[14] From the description the property is not rich in molybdenite.

Garrow Township

A claim was staked in 1915 by Henry Shepherd on lot 10, concession III of Garrow for molybdenite.[15] This property has not been seen by the writer.

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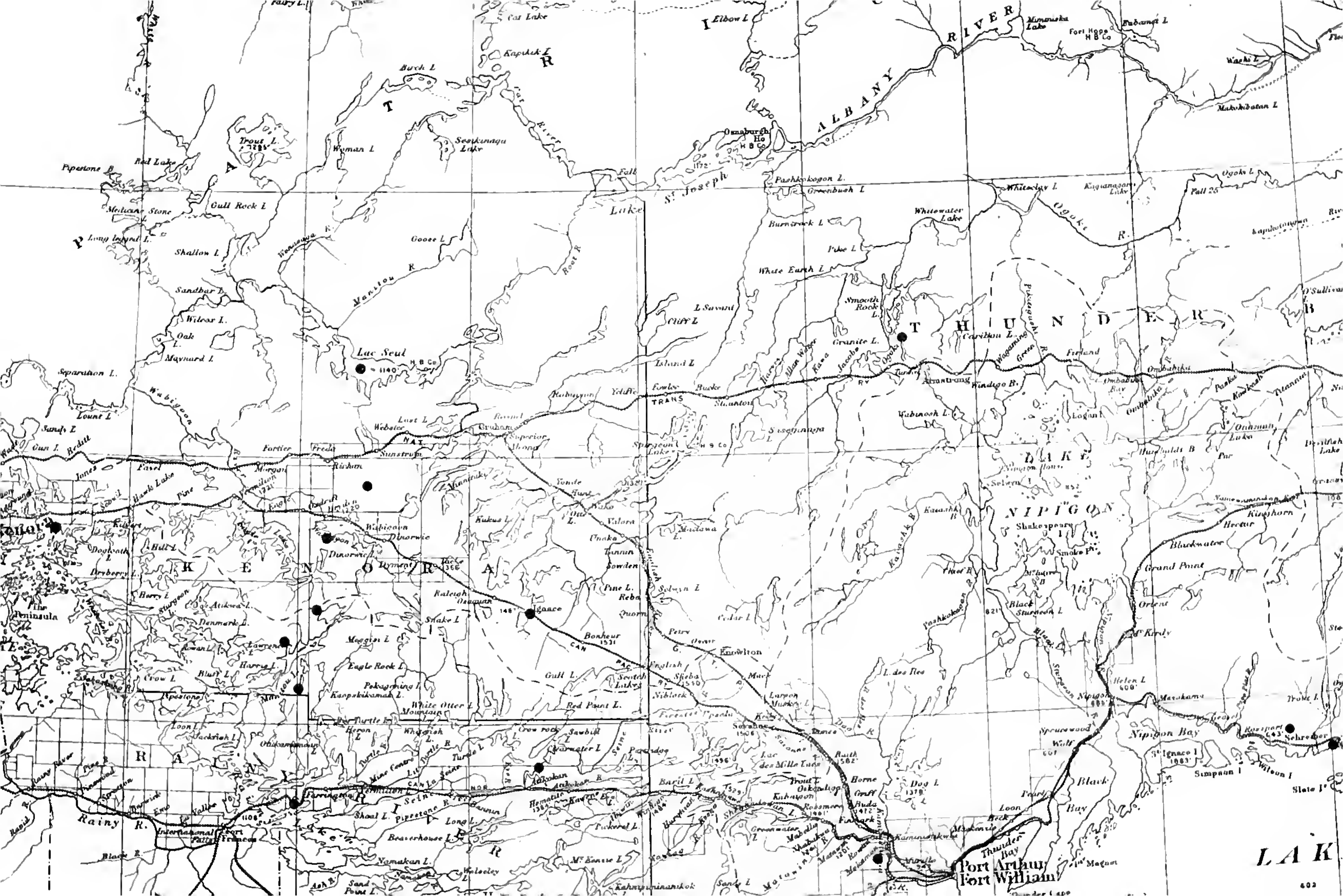
[10] Geo. Sur. Can., Mem. 6, p. 375.
[11] Mines Branch, Sum. Rep., 1915, p. 36.
[12] G. S. C. Ann. Rep., 1892-3, Vol. VI, N.S., p. 7J.
[13] G. S. C. Mem. 6, p. 254, and Mem. 50, 6. 116.
[14] Ont. Bur. Mines, Vol. IX, p. 167.
[15] Ont. Bur. Mines, Vol. XXV, Pt. I, p. 43.

Fig. 11—Spain mine.

Fig. 12—Spain mine.



Albany River
Fort Hope H B Co
Osnaburgh Ho H B Co
Lake St Joseph
Lac Seul H B Co
Kenora
Rainy R.
Rainy River
International Falls
Fort Frances
Ignace
Dinorwic
Wabigoon
Trans Can Pac Ry
Armstrong
Lake Nipigon
Nipigon
Nipigon Bay
Schreiber
Thunder Bay
Port Arthur
Fort William
Kaministikwia
Trout Rock L.
Red Lake
Gull Rock L.
Pipestone R.
Pipestone L.
Shallow L.
Sandbar L.
Wilcox L.
Maynard L.
Separation L.
Lount L.
Manitou R.
Wenasaga R.
Gooee L.
Root R.
Cat Lake
Kapikik L.
Birch L.
Woman L.
Seeikanaga Lake
Cliff L.
Island L.
Pashkokogan L.
Greenbush L.
Burntrock L.
Pike L.
White Earth L.
Smooth Rock L.
Granite L.
Caribou L.
Whiteclay L.
Whitewater Lake
Ogoki R.
Ogoki L.
Elbow L.
Mimnuska Lake
Sturgeon Lake
Wabinosh L.
Shakespeare I.
Grand Point
Blackwater
Helen L.
Black Sturgeon L.
Pashkokogan R.
Kashishk R.
Cedar L.
English R.
Knowlton
Gull L.
Red Paint L.
White Otter L.
Eagle Rock L.
Manitou L.
Lawrence L.
Harris L.
Crow L.
Atikwa L.
Denmark L.
The Peninsula
Dogtooth L.
Dryberry L.
Rice Lake
Pine L.
Hawk Lake
Eagle L.
Vermilion
Atikokan
Atikokan R.
Shoal L.
Pipestone R.
Long L.
Beaverhouse L.
Namakan L.
Seine R.
Dog L.
Kakabeka
Black Bay
Simpson I.
St. Ignace I.
Slate Is.
Loon L.
Lac des Mille Lacs
Savanne
Raith
Graham
Sioux Lookout
Superior Jnct.
Richan
Webster
Fortier
Jones
Sunstrum
Morgan
Dyment
Raleigh
Bonheur
Niblock
Upsala
Sheba
Hurkett
Nipigon House
Helen L.
Marahama
Rossport
Ombabika
LAK

Graham Township or Denison Township, Sudbury Region

Dr. R. Bell mentions the occurrence of molybdenite on the Vermilion river on the line between Graham and Denison townships in quartz veins.[16] This is apparently not of an economic character.

Griffith Township

On lots 31 and 32, concession V, and lot 31, concession IV, Griffith township, is the Spain mine, which was opened up some years ago by Joseph Legree of Renfrew, and by him sold to Wm. J. Spain of New York. The workings consist of two open cuts and a 6 by 9-foot shaft which has been sunk to a depth of 50 feet. At the time of the writer's visit, the entire mining work was confined to one of the open cuts, and the working face is shown in figures 11 and 12. The molybdenite is practically confined to pyroxenite and pegmatite, but is more abundant with the pyroxene. At this particular place the molybdenite is in extremely large flakes and masses, some of which are over a foot in diameter. The working face of the open cut is from 12 to 15 feet high and about 40 feet long. The ore, however, occupies only about half of this width, the mineralized portions being separated by a band of gneiss about 12 feet wide. In figure 12 this gneiss is shown as the prominent feature, the men at the left being almost under the contact between the gneiss and the pyroxene rock, while the trench at the right is in a pyroxene pegmatite mass which, although not so rich in molybdenite as that to the left, is still in good concentrating ore. At the time of the first visit, no concentration was being carried on, but flake molybdenite was being cobbed out from the higher grade ore, and several thousand pounds had been extracted in this way. The mill, which is described in another part of the report, was nearing completion, and the lower grade ore was being reserved for treatment. The country rock at the Spain mine is gneiss, which lies in a nearly horizontal position, and is overlain by a crystalline limestone containing much mica as well as some pyroxene. Some two or three hundred feet in a westerly direction from this pit, another small pit is located in a fine grained pyroxenite, in which the molybdenite occurs as minute scales. This, however, was stated by the manager to be of sufficiently high grade to pay for concentrating.

Gull Lake, Near Dryden

The description of the deposit on Gull lake is furnished by E. Thomson.

This property is situated at a point about one mile due south of the extreme eastern end of Gull lake, a large lake about 15 or 16 miles northeast of Dryden. The molybdenite occurs in a pegmatite dyke, which strikes east and west, with a maximum width of about 6 feet and a total length of 50 feet, and consists almost entirely of quartz and orthoclase, but contains as well subordinate quantities of molybdenite, muscovite, and biotite. This pegmatite dike is intruded in a hornblende schist, which also strikes east and west, similarly to the schist found in the immediate vicinity of Dryden. A small test pit has been sunk on this dike to a depth of about 3 feet, all of the specimens of molybdenite obtained from this locality coming from this pit. Various other pegmatite dikes intrude in the

[16] Geol. Sur. Can., Ann. Rep., 1889-91, Vol. V, N.S., p. 25F.

schist at different points along the same outcrop, some following the strike of the schist, others cutting across it, but these carry no more than a few odd flakes of molybdenite of very small dimensions. The property was visited under the guidance of C. Coates of Dryden, one of the first discoverers of it.

Gull River

Alex. Murray reports the occurrence of molybdenite from the Gull river above Mud Turtle lake.[37] This location may be in Lutterworth township, but is not definitely located.

Fig. 13—Open cut, Harcourt township.

Harcourt Township

In the fall of 1901 mining work was carried on by the Land and Immigration Company, Limited, of Haliburton on lots 2 and 3, concession I of Harcourt township under the direction of S. Dillon Mills, who furnished an excellent description of the deposit for the eleventh report of the Bureau of Mines. Since that time little work has been done. The principal development work consists of an open cut about 50 feet long, 6 feet wide and at its deepest place from 15 to 20 feet deep. This opening is shown in figure 13. Continuing along this outcrop, a shaft about 6 by 8 feet was sunk to a depth of 15 feet. Very little molybdenite was seen either on the dump or on the walls of these openings.

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[37] Geol. Sur. Can., Rep. Prog., 1852-3, p. 145.

A few hundred feet to the south a small excavation from which about forty tons of rock had been removed showed the only encouraging quantity of molybdenite.

The writer estimated the quantity of high grade material that had been laid to one side to be one or two tons. The material was of exceptionally high grade, and came from a nodular mass in the pyroxenite. This property should be further developed, as with the improvements that have been introduced in the concentration of molybdenite, it would be desirable to have a mill run to ascertain the value of the property. It is almost impossible to take a representative sample, as some of the ore is extremely rich, while the rest is poor, but the writer estimates the rich material on the stock pile to be a 10 per cent. ore.

Ignace

Samples of molybdenite in granitic rock were shown the writer in April, 1917, which were said to have been found near Ignace. The flake is small, but other sulphides were absent.

Kirkland Lake

At the Tough-Oakes mine and other mines in this district, molybdenite is found in some abundance, though usually as a thin film. The veins are said to carry quartz, pyrite, chalcopyrite, galena, sphalerite, calcite, ankerite and dolomite.[18] The presence of galena is unusual, but has also been noted at Big Duck lake, north of Lake Superior.

Lake of the Woods Region

On Quarry island near the Sultana gold mine, veinules carrying molybdenite are reported by Lawson.[19]

The writer was informed some years ago that the ore of the Sultana mine carried some molybdenite. It was also seen by the writer in the vein at the Mikado mine, and on mining location D. 149 in Bag bay of Shoal lake.[20] None of these occurrences, however, are rich enough in molybdenite to be used as a source of this material.

Laxton and Somerville Townships

On the shores of Mud turtle lake in the above townships are several localities where molybdenite has been found. It was first mentioned by Alexander Murray[21] who describes the occurrence as follows:

> The white crystalline limestones north of Balsam lake are intersected by huge veins of white quartz, in one of which small masses of sulphuret of molybdenum were found, on a small island in Big Mud Turtle lake; it occurs disseminated in the vein, accompanied by greenish scapolite, green cleavable pyroxene, sometimes assuming a radiated form, and iron pyrites, which is abundantly disseminated in some parts. Specimens were shown to me by an Indian on the same lake, apparently of the same character as those procured by myself, which he stated had been found a few miles higher up the Gull river.

On the north shore of the lake is a deposit upon which work was done many years ago, and a few flakes of molybdenite were still visible. The lessee, Mr. T. Horscroft, was considering further prospecting.

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[18] Ont. Bur. Mines, Vol. XXIII, 1914, Pt. II, p. 21.

[19] Geol. Sur. Can., Ann. Rep., 1885, Vol. I, N.S., p. 144CC.

[20] Ont. Bur. Mines, Vol. XX, 1911, Pt. I, p. 176.

[21] Geol. Sur. Can., Rep. Prog., 1852-3, p. 144-5.

Fig. 14. Trench, Horscroft mine, Laxton township.

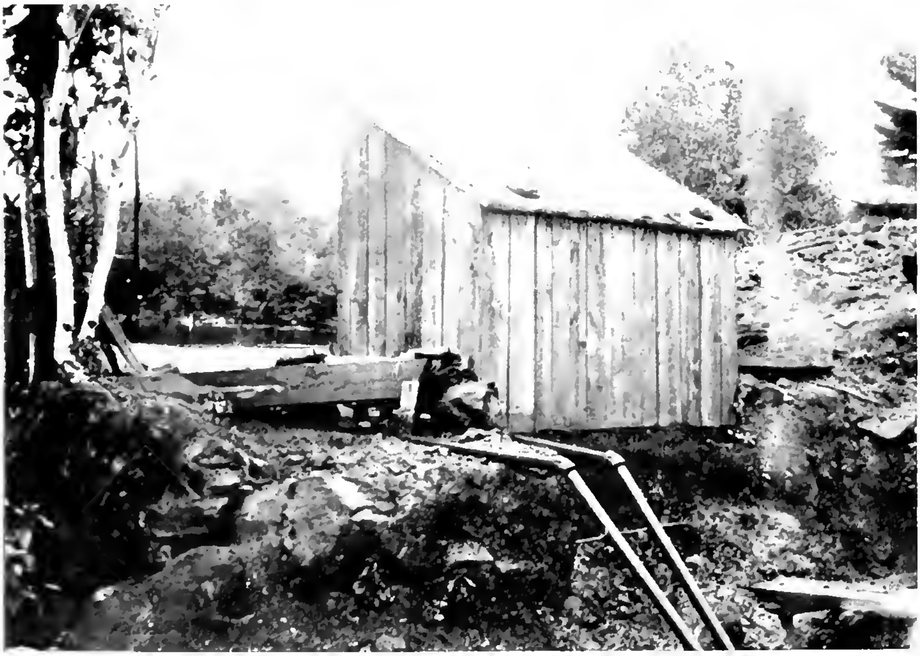

Fig. 15. Pump house, Horscroft mine, Laxton township.

On the west shore of the lake are two mines which from the nature of the case must be discussed together. One is near the water's edge on lot 5, concession XI, Laxton township, and the other is the water lot adjoining.

The mine on the mainland is on the farm of William Adair, and is being worked under lease by T. Horscroft. The property was visited early in May at which time a pit about 12 feet in diameter had been opened up, and a small quantity of molybdenite taken out. The pit was, however, filled with water so that it could not be examined. Mr. Horscroft showed one or two other outcrops of pegmatite which exhibited a few flakes of molybdenite. A second visit in September found the property in better condition for examination, inasmuch as a trench had been extended from the above-mentioned pit for a distance of about 70 feet. The trench was principally in soil and a decomposed pyroxenite, in which considerable molybdenite was present. The pyroxenite was also charac-

Fig. 16—Russell-Ponton mine, Laxton township.

terized by the presence of molybdic ochre or molybdite, which has resulted from the oxidation of molybdenite. The ore body as exposed by this trenching and the pit, is about 75 feet by 20 feet by 10 feet, and would possibly run from 0.3 to 0.6 per cent., MoS_2, but could be easily cobbed to yield a higher grade. Mr. Horscroft reported that he shipped two carloads to the Mines Branch at Ottawa during the summer which carried 2.38 per cent. and 1.08 per cent. MoS_2 respectively.

The trench from which most of this material was taken is shown in figure 14, while the pump-house for de-watering the main pit is shown in figure 15. Two gasoline pumps are used for the pumping.

Adjoining the last mentioned property is the mine which has been sunk by Douglas Ponton and A. J. H. Russell. The general layout of the surface plant is shown in the accompanying view (Fig. 16) which shows the boiler house with the beam of a Cornish pump just at the left of the shaft, while at the right

is a hand derrick: in the foreground is the pit on the Horscroft property as it appeared in May. The shaft, the top of which is shown in the picture, is said to be 50 feet deep and is 7 by 9 feet. Unfortunately, on the occasion of both visits this was full of water, so that the only information concerning the ore body had to be secured by an examination of the stock piles. The ore consists principally of a micaceous pyroxenite, portions of which are of extremely high grade. Several tons of concentrating ore was seen on the stock pile, and considerable high grade material was in the store house. The writer was informed that since his last visit the mine has been pumped out with a view to continuing work.

In addition to the known deposits of molybdenite in this township, the writer observed one or two outcrops on the road between Norland and Coboconk that seemed to furnish the proper association for molybdenite, though unfortunately none of this material was visible. These were contact zones between crystalline limestone and underlying granitic rocks where pyroxene and brown mica were abundant.

Lac Seul

The presence of molybdenite on Lac Seul is reported by Dr. Coleman,[22] who received his information from the manager of the Hudson Bay post.

Longuelac

Samples of molybdenite obtained from a pegmatite near Longuelac were shown at Port Arthur in April, 1917. No information as to the size of the deposit was obtainable. The flakes were large, some being an inch or more across, and the ore appeared to be free from other sulphides.

Lutterworth Township

On lot 7 or 8, concession II, township of Lutterworth, A. Y. Hopkins of Kinmount has opened up a quartz vein containing a little molybdenite. At no place was the vein more than three feet wide, and the molybdenite was not a striking feature of either the material in the vein or of that which had been removed. This vein is in gneiss a short distance from the shore of Davis lake, and is probably not the principal carrier of molybdenite at this locality. A short distance to the west of the vein there is an outcrop of pegmatitic granite, the borders of which are concealed, and in view of the common occurrence of molybdenite on the margins of such masses it is highly probable that prospecting on this margin would result in a further discovery of molybdenite. There is also some molybdenite on a small island a few hundred feet from the shore, but although specks could be seen, the water was over the outcrop and no idea of the importance of the deposit could be obtained.

On lot 7, concession X of the same township, there are two narrow veins carrying molybdenite. The writer did not visit the locality, as no work had been done for years, and the descriptions of the property would indicate that it is not commercially important. This may be the Gull river locality mentioned by Murray.

[22] Ont. Bur. Mines, Vol. V, 1895, p. 61.

Lyndoch Township

On lots 5 and 6, concession VIII of Lyndoch township is the Jameson mine, which was opened up in 1907 by the late R. A. Jamieson of Renfrew. On the occasion of the writer's visit in June, work had been discontinued and the workings were in the condition shown in the accompanying illustration, figure 17. The workings consist of two pits connected by an open trench and about midway between the pits is an inclined shaft as shown in the figure. As is evident from the illustration, very little of the ore body could be examined, as much of it was covered with water, with which the shaft was also filled. The pit shown is the north pit, and the ore body is about six feet wide, lying between gneiss and crystalline limestone, the latter being also in contact with gneiss on

Fig. 17—Jamieson mine. The letters signify respectively limestone, ore and gneiss

the other side, though the immediate contact was not seen. The ore body consists of pyroxenite and pegmatite containing large crystalline flakes of molybdenite, together with a considerable quantity of pyrite and pyrrhotite, making an exceptionally good ore for concentration, as the molybdenite flakes are generally more than a half inch in diameter and can be largely recovered by crushing and screening. The ore which had been exposed on the dump had disintegrated considerably, resulting in the breaking down of the pyroxene, and rendering the ore very friable. In this process of disintegration, the molybdenite is oxidized, and some molybdite formed. The pyrrhotite also undergoes a change, taking on a purple tarnish which is probably due to a thin film of ilsemannite, or possibly some unidentified compound of iron and molybdenum. This property was worked on lease during the winter of 1915-16 by the Orillia Molybdenum Mines, Limited. There were

lying near the blacksmith shop 57 sacks of low grade ore ready for shipment, and in addition there were some other small heaps of concentrating ore which had been prepared for shipment. During the period when the last work was carried on about 285 tons of ore, containing approximately 12,760 pounds of pure molybdenite were taken from this mine.[7] The buildings at the mine proper consist of a blacksmith shop and powder house. The mining camp is situated in the valley at the foot of the mountain upon which the mine is located, and comprises a sleeping house, dining camp, office, storehouse and stable, these quarters being well built and very comfortable.

To the southwest of this property, it is reported that the Orillia Molybdenum Mines have staked a claim called Lybdock, but the writer was unaware of this at the time of his visit, and consequently did not examine it.

Manitou Lake Region

The description of the molybdenite vein on claim A.D. 8 is furnished by E. Thomson:

This property is the old mining claim A. D. 8., situated on a small lake west of Upper Manitou lake, about six or seven miles from the former village of Gold Rock, on that lake. The discovery post of the claim, which has been restaked within the last year by E. D. G. Pidgeon, of Wabigoon, is 11 chains from the northeast corner of the claim on a bearing of S. 21° W. The molybdenite occurs in a very quartzose pegmatite dike, striking about northeast, and with a width at both ends of 10 to 12 feet, and a total length of about 250 feet. This dike consists almost entirely of quartz, which in some places is green in colour, but contains as well lesser amounts of chlorite, orthoclase, molybdenite, bismuthinite, and green and bronze-coloured mica. The molybdenite occurs in intimate association with the chlorite, which is in the form of masses in the middle of the dike. These clumps of chlorite, in all probability, are altered horses of the country rock. This dike outcrops over the summit of a hill about 30 feet in height, at the top of which it separates into two stringers about two feet wide. The outcrop of the dike is best seen at both ends, where it shows its full width of 10 to 12 feet on the sides of this hill. The dike is somewhat more pegmatitic at the southwest end than elsewhere. The neighbouring rock is very basic, consisting almost entirely of hornblende, and is apparently a highly altered pyroxenite. This rock changes to a diorite about 100 feet to the east, which again gives way in a few hundred yards further east to a porphyritic quartz diorite. This last rock is apparently part of the Laurentian granite mass which forms the bulk of the rock in the locality. The property was visited in company with the owner, Mr. Pidgeon.

March Township

On lot 6, concession II, March township, a pit was dug about twenty years ago. This location was not visited by the writer, as he was informed by men who had looked it over with a view to opening it up, that it was not of an economic character. It was visited in June, 1910, by Dr. T. L. Walker, whose report is also unfavourable.[28]

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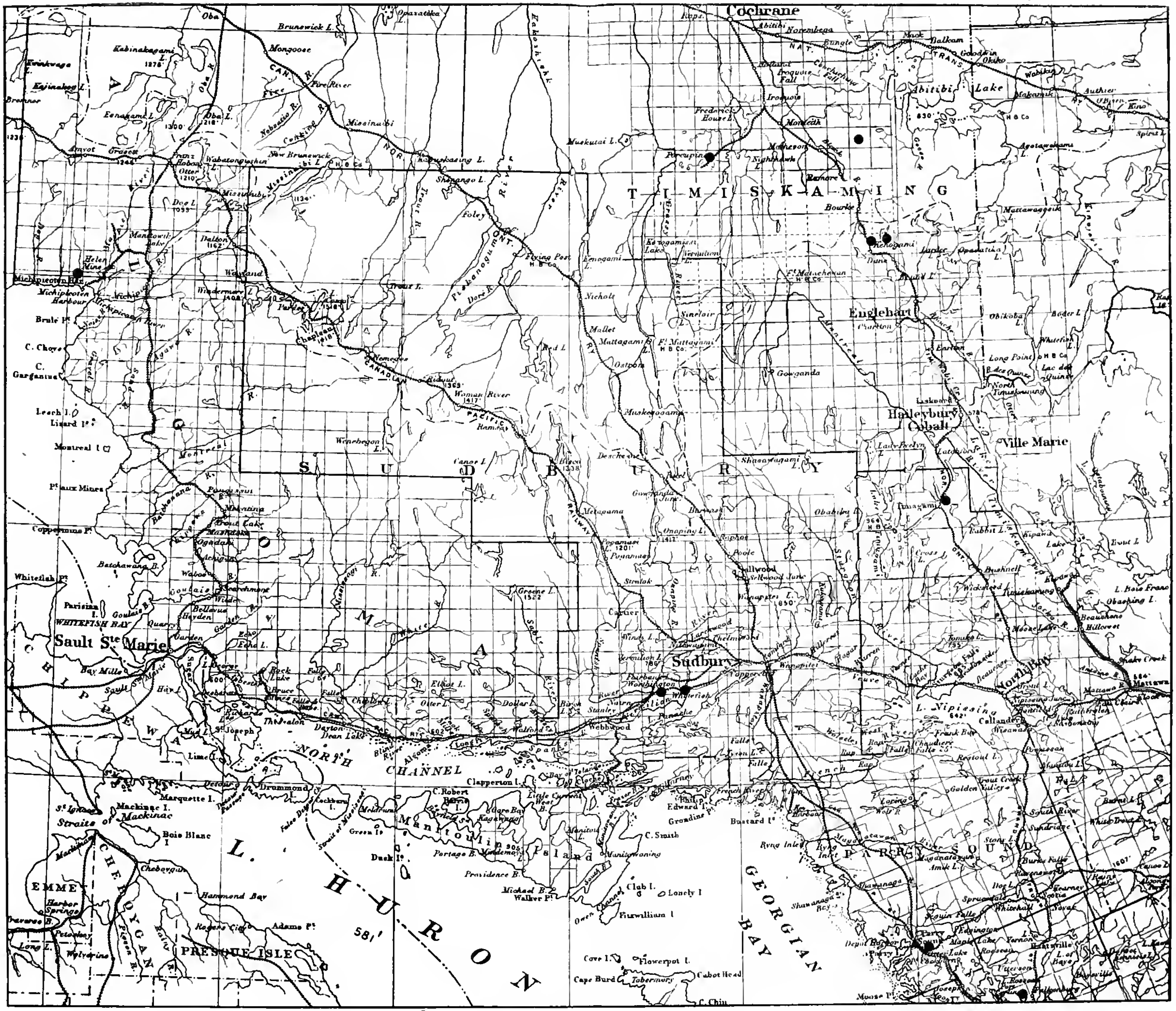
[7] Mines Branch Summary Report, 1915, p. 82.

[28] Mines Branch, Bull. 93, p. 11.



Map of part of Ontario showing location of molybdenite occurrences between Lake Superior and the Quebec boundary. Scale, 35 miles to the inch.

Matawatchan Township

On the farm of James Wilson, lot 3, concession VI, is a large mass of pyroxenite in which molybdenite has been found. Mr. Wilson was not at home, but his son guided the writer to the outcrop. A mass about six feet square by about 15 inches thick had been removed and broken up. In this mass were small scales of molybdenite up to one-half inch in diameter. The pyroxenite is on the margin of a large pegmatite mass, and is from 10 to 50 feet wide. Nothing definite can be said concerning values on the showing that has been made, but it is highly desirable that further prospecting be done, possibly nearer the borders of the pyroxenite.

Miller Township

On lot 5, southwest of the Frontenac road, Miller township, some work has been done by G. C. Shannon of Kingston on the farm of Thomas Armstrong. Mr. Shannon is the owner of the deposit. The workings are on a pegmatite dike cutting gneiss and varying in width from six to eight feet. Three pits have been opened up which are connected by a trench through the surface soil. The more westerly pit is about 12 feet square and was filled with water. The middle pit is about 30 feet long and about 10 feet deep at the deepest portion, while the more easterly one has about the same dimensions as the middle one. Molybdenite was seen in the second and third pits, and a small amount of possibly 1 per cent. ore was laid to one side.

On lot 5, northwest range, the property of John R. Kring, T. L. Walker reports that molybdenite occurs in pegmatite. The association is almost identical with that described above, but this property was not visited by the writer.

Molybdenite has been reported by R. A. A. Johnston[25] on lot 3, concession VIII, but no work has been done, as far as the writer was able to ascertain, for several years.

Molybdenite Lake, Near Michipicoten Harbour

Although this is probably the third locality at which molybdenite was found in Canada, practically nothing is known about either the size or character of the deposit. The first mention of it was made by Sir W. E. Logan who in discussing molybdenite localities says: "Specimens from a third locality were sent me from the River Doré."[26]

Dr. J. M. Bell says:

> A deposit of molybdenite is found in a coarse-grained quartzose pegmatite on the shores of Molybdenite lake on the route between Michipicoten harbour and the Frances mine. I was unable to visit the locality during the summer, but I understand that the deposit is not of commercial importance, as proven by some exploration work done on the property some years ago.[27]

Monck Township

On lot 12, concession VIII of Monck Township near Falkenburg station, about three miles north of Bracebridge, molybdenite has been found in gneiss on the farm of Thomas Stead. Two openings have been made in the gneiss, and

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[25] Mineral Resources of Canada, Bulletin on Molybdenum and Tungsten, 1904, p. 9.
[26] Geol. Sur. Can., Rep. Prog., 1853-54-55-56, p. 40.
[27] Ont. Bur. Mines, Vol. XIV, 1905, Pt. 1, p. 354.

Fig. 18. Ore sacked for shipment, lot 11, concession XV, Monmouth township.

Fig. 19. Molybdenite quarry, lot 13, concession XIII, Monmouth township.

small flakes of molybdenite are to be seen, particularly in the quartzose portion. Except in the material that had been taken out from these openings, no molybdenite was observed, and the quantity that was visible would hardly appear to be of economic value. It is possible, however, that with further development a higher grade body might be disclosed.

Monmouth Township

On lot 11, concession XV, a pit was opened up during the latter part of the past summer by George Padwell in a weathered pyroxenite at the contact of granite and limestone. Figure 18 shows the ore taken from the pit and sacked for shipment. In addition to the ore in the sacks about an equal quantity was in a pile near by to be cobbed and sacked. This ore would probably run from 1½ to 2 per cent. MoS_2. Most of the work done in securing the ore consisted of stripping and taking out loose rock, but drilling had been begun in the less decomposed rock.

On lot 13, concession XIII, Mr. Padwell was engaged during the summer in quarrying the outcrop of pyroxenite shown in figure 19. The quarry face is about 40 to 50 feet long and about 10 feet high, and is entirely in a hard pyroxenite which is in contact with granite. The pyroxenite was traced for about 200 feet. About 15 tons of concentrating ore which would probably run from 1 to 1½ per cent. MoS_2 was set aside in a stock pile.

Mr. Padwell informed the writer that he had shipped a ton of flake molybdenite to the Mines Branch in addition to the material on hand.

A deposit was opened up about a quarter of a mile west of Wilberforce by P. J. Dwyer and associates during the winter of 1916-17, and 25 tons of ore was shipped. The ore as shipped yielded .369 per cent. molybdenite.

Monteagle Township

Molybdenite is reported from lots 26 and 27, concession VI of Monteagle.[28] This locality was examined by the writer without finding any molybdenite. It was also examined by Dr. Walker in 1910 with the same result.

On lot 6, concession I, molybdenite is reported in a quartz vein, but not in economic quantities.[29] This property was not visited by the writer.

At the mine of the National Graphite Company, Limited, near Maynooth, a small quantity of molybdenite has been found. The manager, Ralph Foster, kindly showed the writer over his property, and informed him that in sinking for graphite, molybdenite was usually encountered before the graphite was found, and that the presence of molybdenite is looked upon by the miners at this place as an indication that graphite is near at hand. The molybdenite occurs in a bright, hard pyroxenite, which is rather fine in grain and contains considerable pyrrhotite.

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[28] Geol. Sur. Can., Mem. 6, p. 351.
[29] Ibid.

Net Lake

About four miles north of Timagami station on the Timiskaming and Northern Ontario railway and about a quarter of a mile east of the track, a deposit of molybdenite was opened up about ten years ago. The main ore body, upon which a shaft has been sunk, is about fifty feet wide, and consists of a series of gash veins of quartz carrying chalcopyrite and molybdenite in greenstone. The molybdenite is present in radiating nodules which when broken across give the appearance of a rosette.

The shaft is said to be about 50 feet deep, and about 200 tons of rock and ore are upon the dump. The molybdenite is well distributed in the quartz, and although it did not appear to be rich when compared with other ores, the nodular character of the molybdenite renders the appearance somewhat deceptive, and it is probably richer than it appears to be. The writer would estimate that about one-fifth of the dump consisted of quartz which would run 1 per cent MoS_2.

Fig. 20—Head frame and dump, Net lake molybdenite mine.

Openings were seen in two other places on the property where the veins, although of high grade, are not more than a foot wide. At the time when the work was done good camps were erected. Some of these have, however, been burned, but the boiler house is in fairly good shape, and is provided with hoist and pump. A view of the head frame and dump is given in figure 20.

North Crosby Township

On lot 11, concession V, two pits were opened up many years ago, and molybdenite was found associated with granite or syenite, crystalline limestone, and a dark greenish rock largely made up of pyroxene and scapolite. Dr. Walker

visited this locality and reported that it did not appear to be of economic importance.[30]

Olden Township

G. M. Macdonnell of Kingston, worked a deposit on the south half of lot 7, concession VI, Olden township, and shipped 238 lbs. of molybdenite ore in 1916 from Mountain Grove to the Mines Branch, Ottawa, for treatment. The ore is described by C. S. Parsons who says: "The molybdenite was associated with a gangue consisting chiefly of pink feldspar and pyroxene. Very little pyrite and no mica was observed in the sample." The exact location from which this was derived is not mentioned.

Porcupine Region

Wm. C. Offer shipped 140 lbs. of flake molybdenite and 775 lbs. of concentrating ore to the Mines Branch. The exact location of Mr. Offer's property is not known to the writer.

Raglan Township

On lot 27, in concessions IX and X, three pits have been sunk, and molybdenite was seen on two of the dumps. The best showing is at the pit which is on or near the line between the two properties, and is claimed by the owners of the respective lots. From 30 to 40 tons of rock was taken from this pit, and possibly a ton of 2 to 3 per cent. ore lies on the dump. The ore comes in a pegmatite dike in crystalline limestone, about four feet wide. The other two pits are on concession IX, and although the rock on the dump beside one of these showed molybdenite, none was observed on the walls of the pit. Mr. John Windle owns lot 27, concession IX, and Mr. Herman Liedke lot 27, concession X.

Craigmont

The presence of molybdenite at the corundum mines is recorded by W. L. Goodwin[32] and by A. E. Barlow.[33] From a perusal of the reports the deposit does not appear to be of economic importance for molybdenite.

Rainy Lake

Lawson mentions the occurrence of a quartz vein carrying molybdenite at the contact of the Laurentian and Couchiching at Bear's passage on Rainy lake,[34] but says nothing to encourage the hope that it is of economic character.

Roberts Township

John Mataris staked a claim for molybdenite in Roberts township in 1915.[35]

[30] Mines Branch, Bull. 93, p. 45.
[31] Mines Branch Summary Report, 1915, p. 117.
[32] Ont. Bur. Mines, Vol. XV, 1906, Ann. Rep., Pt. I, p. 43.
[33] G. S. C. Mem. 50, p. 88.
[34] Geol. Sur. Can., Ann. Rep., 1887-88, Vol. III, N.S., p. 180F.
[35] Ont. Bur. Mines, Vol. XXV, 1916, Pt. I, p. 44.

Ross Township

On the farm of John Rose, lot 22, concession II of Ross township, near Haley station on the Canadian Pacific railway, an open cut has been made on a coarse grained pegmatite dike in gneiss. The dike is from two to four feet wide, but the portion that showed molybdenite was under water, so that the estimate of value had to be made on the material on the dump, as the extension of the dike beyond the excavation was not observed to carry molybdenite. The opening is about fifty feet long and from two to eight feet wide, with a depth exceeding six feet in places. The writer estimated that there was about one hundred tons of rock on the dump and about two tons of concentrating ore which he estimated at 1 per cent. MoS_2. Dr. Walker took a sample from this dump and obtained 1.61 per cent. MoS_2, so that the concentrating ore would probably run between one and two per cent. The writer was informed that 10 tons assaying 3.61 per cent. MoS_2 was shipped this season from this property.

On the west half of lot 7, concession IX of Ross township, some excavations were made a few years ago. The writer did not visit this property, as no recent work has been done, and the last published report by Dr. Walker indicated that little could be done.

Sebastopol Township

On the farm of Edward Ziebarth, lots 36, 37 and 38, Range C, South, are two small dikes in gneiss and crystalline limestone in which some molybdenite has been found, but the development up to date has not exposed a deposit of commercial importance. The width of the dikes is about two feet and 18 inches respectively, and they consist of pyritic pyroxenite and pegmatite.

Sheffield Township

On lot 5, concession XIV of this township is located the Chisholm mine, which was worked under option during the spring and early summer by the International Molybdenum Company, with J. F. McKenzie as manager. Nine men were employed in mining operations under what appeared to be very favourable conditions, as the deposit is a flat-lying body of crystalline limestone containing large masses of pyrite, pyrrhotite, hornblende, scapolite, phlogopite and molybdenite, which permitted of open quarry work. At a short distance gneiss was seen, so that although the contact of the two formations was not observed, there is no doubt that it is a typical contact deposit. Two pits had been opened up, and a large body drilled preparatory to blasting. The extent of the work is indicated in figure 21 which shows the larger pit that was opened near the boiler house. Old stock piles were also being removed after preliminary cobbing. At first glance these piles appeared to be rich copper ores carrying molybdenite, as the purple colour so characteristic of bornite and the deep brass yellow of chalcopyrite were very prominent. Instead of being an indication of copper, however, this is probably to be looked upon as an indication of molybdenum, as these minerals proved to be pyrrhotite and pyrite respectively. So far as the writer is aware, this iridescent tarnish of pyrrhotite and pyrite has not been mentioned by any other writer. It is an important point to keep in mind in prospecting for molybdenite, for although the film is too thin to make a satisfactory chemical

examination it probably consists of ilsemannite. Over 200 tons of ore was shipped to Orillia and there concentrated in 1916.

On the farm of Timothy Dwyer, lot 8, concession XV, a pit has been opened up about 8 by 10 feet and ten feet deep, in crystalline limestone. A few flakes of molybdenite were seen which were associated with pyrite, quartz and tourmaline. Pyroxene was not prominent at this pit, though it was present in small quantities. This property was not being worked at the time.

Another deposit was opened up on the farm of Matthew Spratt, lot 8, concession XV, by L. L. Cailloux, but work had been discontinued. An open cut about 10 feet wide by 20 feet long and more than 10 feet deep had been excavated. The bottom of this trench was filled with water, and it was not possible to make a thorough examination. Very little molybdenite was to be seen on the walls of the

Fig. 21—Chisholm mine, pit near boiler house.

cut, but a small stock pile nearby contained a ton or two of low grade ore. The minerals associated with the molybdenite were pyrite, quartz, tourmaline, pyroxene, calcite and dolomite.

On lot 15, concession XVI, on the farm of William Wager, the presence of molybdenite is reported, but the deposit was not seen by the writer.

Five open cuts have been excavated on the farm of A. Kellar, lot 12, concession XIII by O'Brien's-Greenfield of Superior, Wisconsin. At the time of the writer's visit five men were working, and about 160 pounds of pure flake molybdenite had been taken out. The deposits are pegmatite dikes in gneiss, and the molybdenite is principally confined to quartz stringers in the pegmatite. Orthoclase, pyrite, calcite and quartz are the associated minerals of prominence. The work done so far may be looked upon as prospecting, so that the quantity of flake molybdenite saved may be considered encouraging.

Smooth Rock Lake (Manitou Region)

The writer has described the occurrence of molybdenite from two localities on this lake, one in a gold quartz vein, the other as a constituent of trap rock.[36] Neither of the occurrences is of economic importance.

Somerville Township

(*See* Laxton and Somerville.)

Steep Rock Lake

The presence of molybdenite is reported from the vicinity of Steep Rock lake by H. H. Wood, who has a claim on a small lake just over a portage 12 chains long from Steep Rock lake. This small lake is located approximately at N. 48° 49', W. 91° 35'. From Mr. Wood's description the deposit is a quartz vein in chlorite schist at or near the contact with granite. There has not yet been sufficient development to enable a judgment to be formed as to the value of the property.

Swastika

Molybdenite is reported from the Lucky Cross mine.[37]

Talon Chute

The occurrence of molybdenite has been reported from near Talon Chute, about 25 miles east of North Bay. Dr. Walker, however, visited this locality, and found graphite but not molybdenite.[38] So far as the writer has been able to learn, none of those reporting this occurrence state that they saw one in place.

Tamarack Lake

In July, 1917, while examining the area northwest of Lake Nipigon for the Ontario Bureau of Mines, P. E. Hopkins found a large rusty pegmatite dike containing a little disseminated molybdenite. The location of this occurrence is at the extreme north end of Tamarack lake, or about three miles southeast of Smooth Rock lake, district of Thunder Bay.

Terrace Cove

This locality, although not visited by the writer, is worthy of special mention, as it is the first place at which molybdenite was found in Canada,[39] specimens of which were sent by the Geological Survey of Canada to the Exhibition of the Industry of All Nations in London[40] in 1851. A description of the deposits is given by Sir W. E. Logan[41] as follows:

> The adjoining location to the west is described as consisting of red feldspathic gneiss, traversed by large dikes of black trap, and intersected by two sets of veins. One of these appears to occupy the joints of the rock, slipping at a high angle to the northward. These veins are from one to three or four inches in breadth; and they carry in a gangue of quartz,

[36] Ont. Bur. Mines, Vol. XX, 1911, Pt. I, p. 188.
[37] Ont. Bur. Mines, Vol. XXIII, 1914, Pt. II, p. 20.
[38] Mines Branch, Bull. 93, p. 48.
[39] Geol. Surv. Can., Rep. Prog., 1853-4-5-6, p. 40.
[40] Geol. Surv. Can., Rep. Prog., 1851-52, pp. 37 & 41.
[41] Geol. Can., 1863, p. 705.

considerable quantities of yellow and vitreous copper ores, with molybdenite. One vein is, however, described as having a breadth of eight inches, and as having been traced N. 15° E. for a mile and a half, bearing a considerable amount of yellow copper ore, with molybdenite. The other veins are described as running from the shore to a considerable distance inland, and as in many cases remarkable for a breadth of from ten to thirty feet; others attain but a few inches. The gangue of this series of veins is quartz, containing copper pyrites, with occasionally a little galena and blende.

The size of these molybdenite veins is not great enough to warrant exploitation, unless they are of exceptional richness. This, however, does not appear to be the case in view of Logan's statement that of the molybdenite localities mentioned.

The only one of them, so far as known, which affords any available quantity of the mineral is that described as occurring in Quetacheo-Manicougan Bay.[42]

Wabigoon Lake

The following description of the occurrence of molybdenite near Contact bay is given by E. Thomson:

The molybdenite on claim K 645, Contact bay, Wabigoon lake, occurs at a point a few yards from the southwest corner of the claim at the contact between the Laurentian granite and the fine grained Keewatin diorite, in a quartz vein about six inches in width and about 10 feet in length. The vein carries, as well as plates of molybdenite, some pyrite and chalcopyrite. Another occurrence of molybdenite on this same claim is to be found immediately east, at the first point jutting out into the lake east of the Rognon camp. The molybdenite here is right at the water's edge in very small quartz stringers in the regular Keewatin diorite rock, and also to a lesser extent in the country rock itself. It occurs in very tiny flakes, and is associated with pyrite, chalcopyrite, and malachite.

Worthington Mine

Dr. Coleman reports:

Among the minerals at Worthington occasionally a seam of lead gray molybdenite is found crossing the pyrrhotite, or partly enclosed in the greenstone, but the amount is very small. It seems to have been a later deposit in fissures cutting the ore and country rock.[43]

[42] Geol. Can., 1863, p. 755.
[43] Ont. Bur. Mines, Vol. XIV, 1905, Pt. III, p. 161.

EUXENITE, A RADIO-ACTIVE MINERAL

In South Sherbrooke Township, Lanark County

By

WILLET G. MILLER and CYRIL W. KNIGHT

Occurrence near Maberley

In 1915 a quarry was opened about three miles by wagon road from the village of Maberley, on the Canadian Pacific railway, near the centre of lot 13 in the fifth concession of South Sherbrooke township, Lanark county. The new line of the railway lies about one and one-half miles to the south of the quarry. About 2,000 tons of feldspar were shipped from the quarry to the United States for the purpose of extracting potash from the material. A quantity of feldspar suitable for use in pottery was also produced. During mining operations James A. Morrow, the owner of the land, noticed the presence of a brownish-black mineral with a brilliant lustre. Believing the mineral to resemble pitchblende, and knowing the latter to be valuable as a source of radium, Mr. Morrow sent some samples to Thos. W. Gibson, Deputy Minister of Mines for Ontario. Subsequently, specimens were forwarded by Mr. Gibson to Dr. W. R. Dunstan, Director of the Imperial Institute, London, England. A complete chemical analysis of the mineral was kindly made by the Imperial Institute, and it was identified as euxenite.

The writers paid a visit to the quarry in June, 1917, and found that the mineral does not occur in sufficient quantity to be workable by itself. A certain quantity could be produced as a by-product, were the quarry again worked for feldspar.

In a Granite-Pegmatite Dike

The euxenite occurs in a granite-pegmatite dike having a width of some 75 feet. The dike cuts banded gneiss of pre-Cambrian age, and strikes east and west. The gneiss, which strikes about north and south, and dips steeply to the east, consists of more or less parallel bands, the lighter coloured, more acid bands alternating with the darker ones. It has been shown[1] that the oldest rocks in this part of the Province are of Keewatin age, and are composed of volcanic types consisting of pillow lavas, or other closely related materials. On the surface of these rocks a great thickness of sediments, known as the Grenville series, was deposited, but in many localities has since been removed by erosion. The sediments consist of quartzites, greywackés, limestones and other rocks. Both Keewatin and Grenville series have been more or less altered to schists, and over great areas have been intruded by granite. Frequently the granite occurs in roughly parallel lenses or dikes, more or less parallel to the schistosity of the Keewatin and Grenville schists.

[1] Ont. Bur. Mines, Vol. XXII, 1913, Part 2.

This form of granitic intrusion produces a characteristic banded gneiss. Of course other banded gneisses may be formed by the segregation into parallel bands of the lighter coloured and darker coloured constituents of a cooling magma.

Granite pegmatite dikes, similar to that in which the euxenite occurs, are found in the vicinity of the latter. It is not unlikely, therefore, that euxenite or related minerals will be found in other dikes. The dike that contains the euxenite consists mainly of quartz and perthite the latter being a mixture of orthoclase, or microcline, and albite. In addition to these minerals there are found black tourmaline, three varieties of mica, namely, black, white and green, and iron pyrites. The quartz and feldspar have at times been segregated into comparatively large masses; for instance, at the time of our visit there was one mass of quartz exposed on the surface 35 feet long by about 10 feet wide. This mass was found in the centre of the dike with its longer axis running about parallel to the edge of the latter. In some parts of the dike, however, the quartz and feldspar are not coarsely segregated, but occur intermixed in grains or masses from the size of a pea to those three or four inches in diameter. The feldspar and quartz are at times associated in such a way as to produce graphic granite. A casual examination of the materials on the dump might not distinguish euxenite from the more commonly occurring black tourmaline; the lustre of the tourmaline, however, is much duller than that of the euxenite. The part of the dike which has been quarried is about 10 feet wide by 70 feet long, with a vertical face at the west end of about 20 feet in height; the east end of the pit is only a few feet deep.

Description of the Mineral

The specific gravity of the euxenite from South Sherbrooke was determined by W. K. McNeill, Provincial Assayer, to be 4.99. The mineral has a light yellowish-red streak, a subconchoidal fracture and hardness of 6.5. The colour is brownish-black, and the lustre brilliant. It occurs in grains, or masses, from the size of a pea to about two inches in diameter. The mineral is found embedded in pink feldspar, or black scaly mica; it may be added that iron pyrites is usually closely associated with it. Crystals of the mineral were not obtained, but crystal outlines were noted in cases where the euxenite was embedded in the pink feldspar. Owing to the brittleness of the mineral it is difficult to free crystals from their matrix. The material occurs sparsely disseminated throughout the dike, but is found in largest quantity about the centre of the latter, in a zone two feet wide. The zone consists of pink feldspar in which are more or less parallel seams of black scaly mica from an eighth to half an inch wide. Iron pyrites is found in this zone, and, owing to its being partly decomposed, the feldspar associated with the euxenite is discoloured.

Chemical Analysis

The analysis of the South Sherbrooke euxenite, Column I, was made by the Imperial Institute, London. The analysis in Column II is quoted from Dana.[2]

	South Sherbrooke Ontario.	Alve, Norway.
	1	2
	Per cent.	Per cent.
Tantalic oxide, Ta_2O_5	13.89	
Niobic oxide, Nb_2O_5	12.73	35.09
Titanium dioxide, TiO_2	27.70	21.16
Thoria, ThO_2	1.34	
Ceria and allied oxides, Ce_2O_3, La_2O_3, etc.	0.62	3.17 (Ce_2O_3)
Yttria and allied oxides, Y_2O_3, etc.	25.64	27.48 (Y_2O_3)
Ferric oxide, Fe_2O_3	2.63	
Ferrous oxide, FeO	0.51	1.38
Manganese oxide, MnO	trace	
Lead oxide, PbO	0.20	
Uranium oxide, U_3O_8	10.50	4.78 (UO_2)
Erbium, Er_2O_3		3.40
Lime, CaO	0.09	
Magnesia, MgO	0.12	
Silica, SiO_2	0.74	
Loss on ignition, H_2O, etc.	3.00	2.63 (H_2O)
	99.71	99.09
Specific gravity	4.99	5.00
Index of Refraction (n)	2.21 ± 0.01	

Euxenite occurs in several localities in Norway. It is also reported by A. Lacroix to probably occur in Madagascar, but the mineral was not definitely determined.[3] In the latter locality it is found in a granite pegmatite.

Referring to the analysis of the South Sherbrooke euxenite, Dr. Dunstan says:

> Assuming that the radium-uranium ratio in this mineral is normal, viz., 3.4×10^{-7}, the quantity of radium present in one ton of ore would be about 30 milligrams.
>
> The mineral should be of value as a source of uranium and radium if it is obtainable in considerable amount.[4]

A large number of minerals containing the rare earths and other elements are found in association with the feldspar, mica and quartz of pegmatite dikes in various parts of the world. Owing to the difficulty of making chemical analyses of them, their identification in many cases can be considered to be only provisional. Among these minerals reported from the Province of Quebec are the following[5]: uraninite and monazite from Villeneuve mica mine, Lièvre river; samarskite and fergusonite from Maisonneuve mica mine, Berthier county; cleveite, Pied des Monts mine, Murray bay; orthite or allanite, Taché township, Lake St. John. Columbite and other minerals occur with beryls and amazonite in a pegmatite on

[2] Descriptive Mineralogy, 6th Ed., p. 744.

[3] Bull. de la Soc. Franc. de Mineralogie.

[4] A useful book dealing with the uses of these elements is entitled "The Rare Earth Industry," by Sydney J. Johnstone, Senior Assistant, Scientific and Technical Department, Imperial Institute, with a chapter on "The Industry of Radio-active Substances," by Alexander S. Russell.

[5] J. Obalski, Can. Min. Inst., Vol. IX, pp. 72-73.

lot 23 in the fifteenth concession of the township of Lyndoch, Renfrew county, Ont.[6] Reference to other occurrences of these minerals in Canada are given in R. A. A. Johnston's "A List of Canadian Mineral Occurrences."[7]

That there is at least one other rare mineral, in addition to euxenite, in the South Sherbrooke deposit is seen from the following quotation from a letter, dated Oct. 1st, 1917, from Mr. R. A. A. Johnston, mineralogist and curator of the Geological Survey, Ottawa, to W. G. Miller:

> . . . . . there has come into my hands a large specimen of the material, which I have had sectioned. The section shows that instead of there being but one mineral there are two. The euxenite generally forms well-defined layers, whereas the other mineral, which is of a paler shade and shows a distinctly sub-metallic lustre, forms nodules from the size of a pea up to three-quarters of an inch in diameter in the euxenite.

[6] W. G. Miller, Ont. Bur. Mines, Vol. VII, 1898, pp. 234-237, 1897.

[7] Memoir 74, Geol. Sur. Canada.

LATERITIC ORE DEPOSITS*

With Comments on the Nature of Laterites in General

By

WILLET G. MILLER

Introduction

Although ore deposits of lateritic origin do not occur in Canada they are, at least, of economic interest here. The nickel ores of New Caledonia, which has been the only serious competitor with Sudbury, and the nickeliferous iron ores of Cuba, the production of which may have some effect on the output of the iron ores of the Lake Superior region, are of the nature of laterite.

While the name laterite was introduced over a century ago, 1807, for certain superficial deposits, red "earth," of India, from which bricks (*later*, a brick) were made, it is only within the last two decades that careful study has begun to be undertaken of the materials to which the name has been more or less loosely applied. During the last ten years, a number of papers dealing with laterites have been published in the Geological Magazine, and the Geological Survey of India has given much attention to the subject. It would appear, however, that much systematic work remains to be done.

L. L. Fermor says: Few natural mineral products have aroused more general interest or been more provocative of discussion amongst geologists than that superficial rock-formation so typical of the tropics known as laterite. This material excites interest not only because of its chemical composition, but also on account of its wide distribution. It has been recorded, for instance, from tropical South America (e.g., the Guianas and Brazil), Central Africa (e.g., Guinea and East Africa), the Seychelles, India, the Malay Peninsula, the East Indies and Western Australia. Many papers have been published dealing with its distribution, composition, and also its origin, to explain which many hypotheses have been invented.[1]

From following quotations concerning the character of laterite, it will be seen that only two kinds of superficial weathering of silicate rocks have been recognized, by writers on the subject, viz., (1) that which gives rise to so-called laterite, silica and certain other constituents being practically all carried off in solution, and (2) weathering in temperate climates which gives rise to clay, in which the silica remains combined with alumina and water. The author desires to point out, however, that there are at least two other kinds of weathering, viz., (3) that represented by the nickel ores of New Caledonia, which contain a comparatively high percentage of silica combined with magnesium and other elements, and (4) the bauxite deposits of Arkansas, higher in silica in certain of their upper layers than in the bauxite below. Tables of analyses of both the New Caledonia nickel ores and the bauxites of Arkansas are given on following pages. From a consideration of them it would appear that the present, accepted definition of the term laterite should be modified, or that the term should be employed only in its former general or stratigraphic sense.

A brief description of the lateritic deposits of the several metals, that occur in important quantities in such deposits, is given on following pages.

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*A paper presented before the Royal Society of Canada, Section IV, May, 1917.

[1] Geol. Mag., Vol. VIII, 1911, p. 454.

Although the Cuban deposits have been studied only within the last ten years, a much more systematic chemical examination has been made of them than of laterites in any other part of the world. Indeed, practically the only published analyses of laterites at various depths in the deposits are those of Cuba. Writers on other deposits have been content, in most cases, to give analyses representing merely the upper parts of the weathered material, thus ignoring the fact that there is no sharp line of division between the more highly oxidized and leached capping and the underlying material. As shown in a following table of analyses, a high percentage of alumina, for example, is characteristic of only a foot or two of the uppermost part of some deposits, while in other cases it extends downward much farther. The most detailed analyses available, those of Cuban deposits, 35 or 40 feet in thickness, that have been made of samples, representing each foot in thickness, show clearly that the change in chemical composition is gradual. The name laterite should, therefore, not be applied merely to the red-coloured surface layers of the deposits. In Cuba the iron-ore deposits at Mayari are mined by steam-shovel methods to an average depth of about 19 feet. The upper layer, 5 or 6 feet in thickness, is of a crimson-brown hue; the middle layer, of greater thickness, is yellowish-brown, and the lower layer, also 5 or 6 feet thick, is of a lighter shade of yellowish-brown. The difference in colour of the layers is due chiefly to the state of oxidation of the iron, but is also influenced by the percentage of alumina.[1]

As a member of the Royal Ontario Nickel Commission, the author visited both Cuba and New Caledonia during the year 1916. The deposits of these two widely separated islands are the most important from the economic point of view of any of those yet exploited. It may be added that the cobalt deposits of New Caledonia, also of lateritic origin, controlled the world's markets for the ore of this metal, prior to 1903 when those of Cobalt, Ontario, were discovered.

In addition to those of iron, nickel and cobalt, other ores of lateritic origin that have been worked include certain manganese, aluminum (bauxite) and gold deposits. Lateritic ores emphasize the importance of the igneous rocks, especially, as a source of metals.

In discussions which have taken place as to the character of laterite, it has been generally agreed that the term should be applied to subaerial decomposition products that contain a low percentage of combined silica, existing as hydrated aluminum silicate, as contrasted with clays of similar origin. Fermor would limit the combined silica to 5 per cent. in pure laterite. It will be seen from following analyses of the Cuban materials, from the surface to a depth of twenty feet or more, table No. 1, that they fall within Fermor's classification of laterites. On the other hand, the New Caledonia nickel ores contain from 35 to 50 per cent. of silica, table No. 2, not in the form of clay but with much hydrated nickel magnesium silicate. The question then arises as to whether or not these New Caledonia materials should be classed as laterites as defined by Fermor and other writers. While they contain iron and aluminum in the form found in what have been called true laterites, they differ from them in the content

[1] A list of publications on the Cuban deposits is given in J. F. Kemp's instructive paper, The Mayari Iron-Ore Deposits of Cuba, A.I.M.E., Vol. LI, 1915.

of combined silica and in the comparatively high percentage of magnesia. These nickel ores do not seem to have been considered by the various writers who have discussed the question "What is laterite?"

Laterite and Clay

Fermor defines laterite, and distinguishes it from clay, in the following words:—

One should not decide whether a given rock is laterite on the basis of the presence or absence of alumina in quantity, but on the presence or absence of any considerable proportion of combined silica. Combined silica means the presence of kaolin or lithomarge, and the larger the amount of such material the closer does the rock approach a clay in composition. Now clays[a] are to be regarded as the end products resulting from one mode of superficial decomposition of rocks, and laterites as the end products of another totally distinct mode of decomposition. When a rock breaks down into a *clay* hydrated aluminum silicate is to be regarded as the pure end product, all oxides being removed in solution. When a rock is converted into *laterite*, on the other hand, the reverse holds; aluminum and other silicates are decomposed, and the silicate is removed in solution, presumably in the colloidal form, whilst the oxides of iron, aluminum, titanium, and manganese, which were relatively soluble under the clay-forming conditions, are relatively insoluble under laterite-forming conditions. The oxides of calcium, magnesium, sodium, and potassium are apparently soluble under both sets of conditions. I do not propose to advance here any reasons to account for these two diverse modes of surface alteration of rocks, nor to say anything about the conditions, whether climatic or organic, that bring them about, but to deal only with the results of such changes. *Pure clay*, then, is hydrated aluminum silicate, whilst *pure laterite* is a mixture of one or more, or all, of the oxides of iron, aluminum, titanium, and manganese, more or less hydrated, which I refer to in this paper as the lateritic constituents. Manganese oxide is a somewhat exceptional constituent, and when present usually segregates into masses of comparatively rich manganese-ore, as a rule either psilomelane or pyrolusite.[1]

C. M. Weld in describing the Cuban deposits gives a definition of laterite similar to that of Fermor, as follows: "The ore is, in fact, a laterite, a product due to the peculiar form of decomposition known as laterization, which is common to humid tropical climates. The essential characteristic of laterization is the breaking-up of the silicates, with the ultimate almost complete removal of the silica, wherein it differs radically from the kaolinization-processes of the temperate zones."[2]

In order to show the difference in the products of weathering of rocks of similar character in tropical and temperate climates, respectively, Hugh Warth published some interesting analyses of dolerites of India and Great Britain and of their weathered products. The following table shows the results of analyses, the comments on the table being taken from Warth's paper:—

Column i of the table represents the composition of the original Rowley Regis rock, which was obtained as the average of three analyses, two of them by J. H. Waller and a third analysis by Henry.

Column ii, the weathered product of Rowley Regis (steam dry).

Column iii, composition of Dolerite from Poonah on the Western Ghâts in the Bombay Presidency (analysed by my son F. J. Warth, M.Sc.).

Column iv, the composition of the Laterite which rests on the dolerite at Mahabaleshwar, which is also situated on the Western Ghâts (see p. 155, Dec. iv, Vol. X, of this Magazine, April, 1903, by H. & F. J. Warth).

[a] *i.e.*, clays formed in situ as distinguished from those deposited as aqueous sediments.
[1] Geol. Mag., Vol. VIII, 1911, pp. 459, 460.
[2] A.I.M.E., Vol. XL, p. 305.
[3] Geol. Mag., 1905, p. 21.

	Rowley Regis		Western Ghats	
	I	II	III	IV
SiO_2	49.3	17.0	50.4	.7
TiO_2	.4	1.8	.9	.4
P_2O_5	.2	.7	....	....
Al_2O_3	17.4	18.5	22.2	50.5
Fe_2O_3	2.7	14.6	9.0	23.4
FeO	8.3	....	3.6	....
MgO	4.7	5.2	1.5	....
CaO	8.7	1.5	8.4	....
K_2O	1.8	2.5	1.8	....
Na_2O	4.0	.3	.9	....
H_2O	2.9	7.2	.9	25.0
Total	100.4	99.3	100.5	100.0

This table shows the striking difference between the weathering of the Rowley Regis Dolerite and that of the Dolerite of Poonah, which so far may represent the whole of the Deccan Trap. Whilst the Rowley Regis Dolerite yields a product (column ii) which differs comparatively little from the original rock, this Dolerite of the Western Ghâts is altogether changed into a mixture of aluminum hydrate and ferric oxide, the most remarkable fact being the nearly perfect removal of the silica in the latter case. . . .

No chemical reaction is known which can account for such a complete removal of silica as has occurred in India, neither is there any explanation why such a reaction should work in India and not in England. The only hypothesis we have is the one based on Mr. T. H. Holland's novel and ingenious suggestion that the silica might be rendered soluble by lowly organisms which can thrive in the uniformly warm climate of the tropics, and not in a region of lower and varying temperature. However, there is as yet no actual proof for this hypothesis, and under the circumstances it may not be inappropriate once again to draw the attention of chemists to this remarkable phenomenon in case there might after all be a strictly chemical solution of the problem.

The weathered product from India may be classed as bauxite. In the Rowley Regis rock there is no tendency towards the formation of bauxite. The weathered material on the surface of the dolerite in the latter locality has a thickness of about twenty feet.

That very few chemical examinations of laterites have been made till recent years is shown by the following quotation from T. H. Holland's paper published in 1903.[1] Laterites had been frequently described as ferruginous clays. Holland says: "Dr. Warth's suggestion naturally occurred to me, and steps were taken to investigate the chemical constitution of laterite; but before any real progress in the work had been made, Dr. Bauer's paper appeared, and, as I think, practically settled the question. What is true of the Seychelle laterite must, so far as one can judge, be true also of the laterites in India which have not been sifted by running water."

Regarding the origin of laterites Holland says:[2]

Now, putting these facts together, I would suggest that we look for the explanation of laterite, not in simple chemical reactions, but in the action of some lowly organism having the power of separating the alumina, which, after the manner of many plants, it does not want, from the silica, which is necessary for its life, but which, being in a soluble form, is removed again by the alkaline solutions. Such a form of life might thrive in the moist climate of the tropics, even to a temperate altitude, but might find life intolerable in a land subject to severe winters, such as we get in the temperate zone and in North India, where

[1] Geol. Mag., 1903, p. 60.

[2] Ibid, p. 63.

we find no laterite. Such an organism would form [illegible] as well as laterite in a moist, warm climate, the difference in the products being due merely to their after treatment by water. For obvious reasons, too, such an organism could not live under conditions of kaolinization. But apart from the agency of life I see no chemical reason why an aluminous silicate should undergo a more complete decomposition at the comparatively low temperature of the tropics than at the high temperature of subterranean situations; the contrary, indeed, seems more natural. And if the temperature *does* so affect chemical action we still might wonder why laterite does not occur on the foot hills of the Himalayas, where there is an abundance of moisture and where the average annual temperature is as high as on the Nilgiris. Chemical changes which cease at low temperatures commence again as soon as the suitable physical conditions are restored, and laterite, consequently, would be expected to form in North India during the summer. But the distribution of an organism might very well be limited by the extremes of climate, when possibly the average annual temperature is not below what would be congenial to it if maintained.

If this fancy turns out to be well founded we must add laterization to the long list of tropical diseases, against which even the very rocks are not safe. But it is a big step between the establishment of a reasonable suspicion and the actual detection of the bacillus at work. There may be many forms of life taking advantage of the soft, moist, lateritic medium, but it will not be an easy matter to convict, amongst these, such as may take an active part in breaking up the aluminous silicates.

It is hard to believe that the few degrees by which a tropical exceeds a temperate climate is sufficient to so strikingly increase the chemical activity of the weak organic acids percolating through the soil. But that such a small difference of temperature affects low forms of life is painfully evident to those who have to maintain the daily fight of life in the tropics.

Laterization Conditions in Cuba and New Caledonia

While certain features of Cuba are similar to those of New Caledonia, both being islands and the one lying about the same distance north of the equator that the other does to the south, the temperature and rainfall, factors in laterization, are somewhat different. The mean temperature of Cuba is given as 76.8°, the lowest average occurring in January when it is 70.3° and the highest in July, when it is 82.1°; the average rainfall for the past twenty-five years has been 53.57 inches.[1] This average temperature has apparently been determined without taking into consideration that of the greater altitudes. The mean minimum temperature of New Caledonia is said to be 63° and the mean maximum 83°; between 1908 and 1912 the average rainfall was 72.6 inches, but varies greatly in different years, in 1910 being 96 inches while in 1911 it was 19.7.[2] There is, of course, no means of determining what changes have taken place in the climates of the two islands during the vast period in which laterization has been in progress.

While the process of laterization is still in progress on both islands, the greater part of the deposits was formed long ago. A. C. Spencer says: "The residual ores of Cuba were formed in Tertiary time, in large part, and perhaps entirely, prior to the deposition of the Lafayette (Pliocene) formation of the Atlantic Coastal plain." The basic rocks from which the serpentine of New Caledonia has been derived are considered to be of post-Cretaceous age.

Regarding the mode of formation of the Cuban ores, C. M. Weld has said: "At the same time there is no reason to suppose that laterization processes have ceased; it is in fact probable that new ores are forming to-day wherever opportunity offers. Such opportunity may be considered as at a minimum on the plateaus.

[1] Official Handbook, "Cuba Before the World," Panama Pacific International Exposition, 1915, p. 22.

[2] Report Roy. Ont. Ni. Com., p. 246.

[3] Occurrence, Origin and Character of the Surficial Iron Ores of Camaguey and Oriente Provinces, Cuba. A.I.M.E., Vol. XLII, p. 106.

where heavy mantles of material lying nearly horizontally effectively protect the underlying rock from the action of the surface waters."[1] The occurrence of the Cuban ores, for the most part, on plateaus presents a difference from that of the nickel ores of New Caledonia which are found on hillsides. Many of the serpentine areas of the latter island are broken and dissected, and the plateau structure is not prominent. Hence there has been more working over of the laterite in this island than in Cuba, and there has been more opportunity for the concentration of the nickel contents, the metal being first leached out by water and then deposited at lower levels on the hillsides. Fissures in the rocks also assist in concentration of the nickel.

In general appearance the deposits of Cuba and New Caledonia present a striking likeness, only chemical analysis brings out the fact that certain of the deposits of the latter island are much richer in nickel than any of those discovered in Cuba, and that they contain a large percentage of combined silica and of magnesia.

Composition of Laterites

Table No. 1 shows the composition of laterites from several countries. It has been compiled from various publications.[2] The analyses of the New Caledonia samples were kindly made for the author by A. L. Clark of Toronto. In certain cases magnesia and other constituents while present have not been determined. Much more complete analyses of the New Caledonia nickel ores are given in table No. 2. This table is of special interest, owing to the content of silica and magnesia of the ores. The composition of the New Caledonia cobalt ores is given in table No. 3, that of the Cuban iron ores in table No. 4, manganese ores of India in No. 5, and bauxite or aluminum ores of Arkansas in No. 6.

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[1] The Residual Iron Ores of Cuba, A.I.M.E., Vol. XL, p. 310.

[2] Analyses of Cuban samples are taken from publications by Kemp and by Leith and Mead, to which reference is made in this paper; the analysis, India (1), is quoted on a preceding page; that of India (2) is quoted by Clarke, data of Geo. Chem., 3rd Ed., p. 495; that of F. Guinea is from A. Lacroix; those of Borneo and the Philippine Ids. are from Roy. Ont. Ni. Com. Report, pp. 266 and 278.

TABLE No. 1

Analyses of Laterites at Various Depths from Surface

(Note Content of Silica and Magnesia in New Caledonia Ores, Table No. 2.)

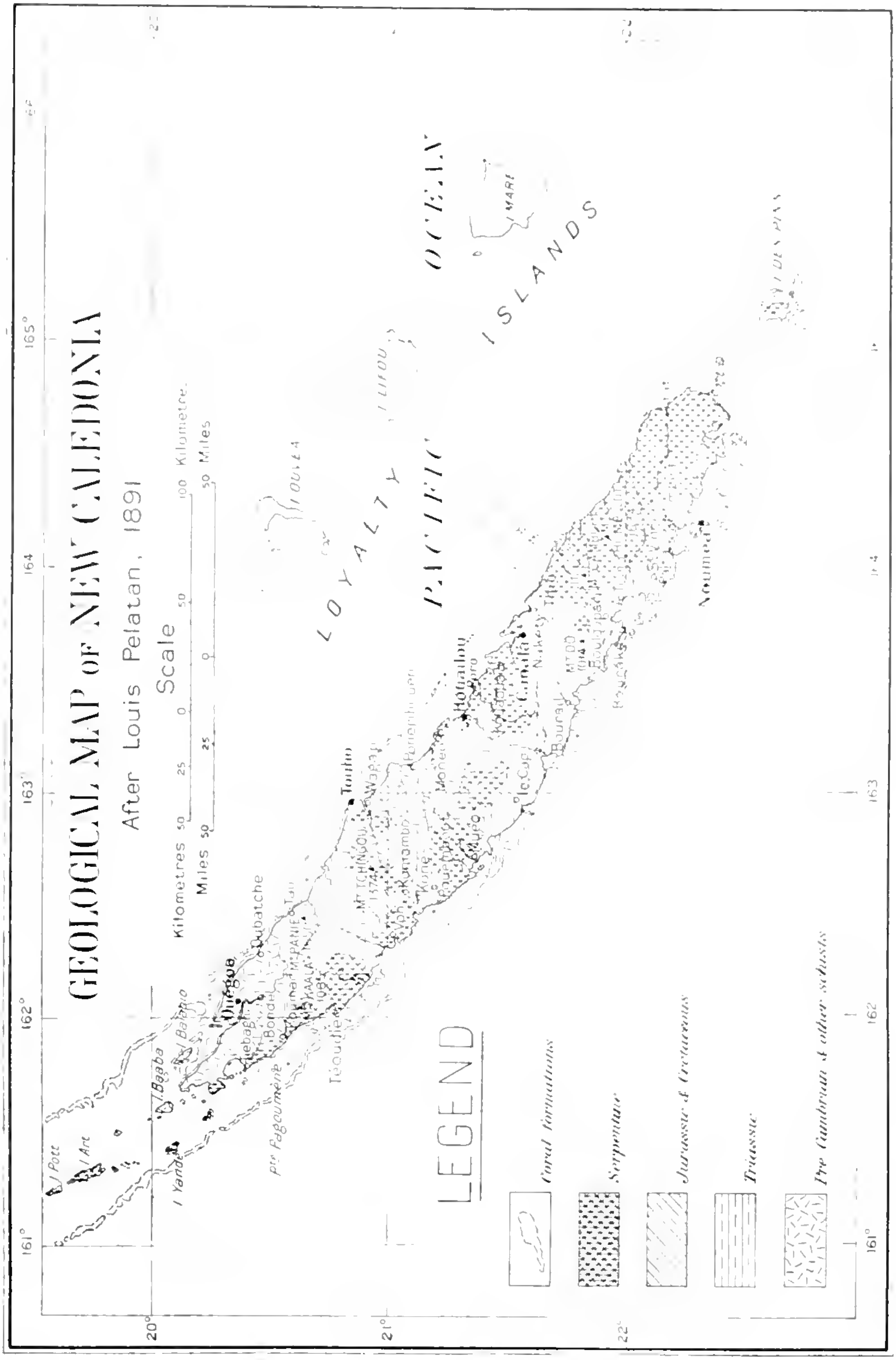
	Depth Feet	SiO_2	TiO_2	MgO	H_2O	Cr_2O_3	Al_2O_3	Fe	Ni+Co
1st Layer.									
Kataviti, N. Caledonia	0–1½	4.2	......	0.25	11.20	2.10	5.8	51.1	1.95
Dumbéa, N. Caledonia	0–4	5.8	......	0.30	......	......	6.1	50.0	1.69
Mayari, Cuba, 1	0–4	2.49	......	......	9.87	1.42	17.04	46.4	0.37
Mayari, Cuba, 2	....	2.26	......	......	11.15	1.89	14.9	48.65	0.59
India, 1	....	0.70	0.40	......	25.00	......	50.5	16.38	....
India, 2	....	0.90	1.59	0.20	14.39	......	26.27	56.01	....
F. Guinea	....	2.80	......	......	11.40	trace	8.7	54.04	....
Borneo	0–6	2.75	......	......	......	3.36	......	53.09	0.39
Philippine Ids.	surface	1.04	......	......	6.66	1.15	10.56	54.29	....
2nd Layer.									
Kataviti	1½–3	26.4	......	15.60	12.60	1.30	2.4	18.3	6.66
Dumbéa	4–8	8.2	......	1.70	11.20	......	4.0	47.5	1.47
Mayari, 1	4–8	2.33	......	......	11.00	2.66	7.95	50.32	0.92
Mayari, 2	....	2.76	......	......	12.90	3.17	7.15	51.42	1.20
Borneo	6–9	2.35	......	......	......	3.22	......	50.01	0.41
3rd Layer.									
Kataviti	3–4½	32.2	trace	......	......	0.55	1.5	11.7	7.49
Dumbéa	8–12	23.6	trace	4.8	8.70	1.50	2.8	35.5	2.05
Mayari, 1	8–12	2.72	......	......	12.31	3.11	6.88	50.04	1.25
Mayari, 2	....	7.54	......	1.5	12.75	3.66	4.97	46.52	2.10
Borneo	9–15	2.30	......	......	......	2.99	......	51.69	0.45
4th Layer.									
Dumbéa	12–16	45.0	......	15.80	6.70	......	0.9	16.8	2.49
Mayari, 1	12–16	2.6	......	......	12.85	2.75	6.52	47.18	1.36
5th Layer.									
Dumbéa	16–20	42.8	......	......	......	......	4.8	16.3	3.64
Mayari, 1	16–20	4.17	......	......	12.25	3.33	6.74	47.72	1.36
6th Layer.									
Mayari, 1	20–24	10.71	......	......	12.74	3.08	5.80	43.79	1.58
7th Layer.									
Mayari, 1	24–29	35.99	......	21.56	14.57	2.12	4.11	29.50	1.74

Nickel Ores

New Caledonia has been a producer of nickel ores of lateritic origin since 1875[1]. Similar ores in another French island, Madagascar, have attracted attention during recent years but little mining has been done there[2]. Garnierite ores, like those of the two countries just mentioned, have also been shipped from Greece.[3]

New Caledonia, between latitude 20° 5′ and 22° 16′ S. and between longitude 164° and 167° 50′ E., has a length of about 250 miles and an average breadth of less than 30 miles, the maximum being about 40. Serpentine, derived from peridotites and other basic rocks, occupies about one-third of the surface of the island. Resting in situ over much of the surface of the serpentine are loose products of weathering of varying thicknesses, at least the upper parts of

[1] Report Roy. Ont. Ni. Com., pp. 234-264.
[2] Ibid., pp. 276, 277.
[3] Ibid., pp. 272-275.



Map of New Caledonia

which, as shown from the analyses in a preceding table, would be called laterite. But, taken as a whole, these products of weathering, as the analyses show, differ greatly, especially in their content of combined silica, from those that have been described as true laterites from other countries. They also differ from clays in that the silica does not exist in combination with the alumina but with magnesium, nickel, and other elements, the hydrated nickel-magnesium silicate, garnierite, being the most important economic constituent.

The following table, No. 2, of analyses of ores, that are shipped from various localities in the island, shows a striking difference, in the high percentages of silica and magnesia, and the comparatively low percentages of alumina and iron, from the lateritic iron ores of Cuba, for instance. Other analyses are given in table No. 1.

Mining Lateritic Nickel Ore, New Caledonia.

In mining, the upper layer of the deposits, high in iron and low in magnesia and silica, is stripped off. This layer, as shown in the case of the Kataviti mine, in analyses given in table No. 1, is sometimes only a foot or two in thickness, but sometimes much greater. Then the ore, richer in nickel, lying below, is excavated down to a point where the rock becomes hard and compact. The decomposed rim, of a thickness of two or three inches or more, that coats the surface of boulders, that lie near the bottom of the loose material, is scraped off and added to the ore pile. The ore is piled in small heaps, carefully sampled, and the lower-grade ore mixed with the higher so as to form a product containing, as the table shows, an average of about six per cent. of nickel. The lateritic iron ore is not used, although it occurs in quantity on the island in deposits parts of which are workable as sources of nickel and elsewhere.

Production of nickel ore began in Sudbury in 1887, but the competition with New Caledonia was so keen that it was not until 1905 that Sudbury definitely outdistanced its rival. With the exception of Sudbury, New Caledonia has no

TABLE No. 21

Selected Analyses of Types of New Caledonia Nickel Ores

Name of Mine.	Situation.	Per cent H_2O dried at 100°C	Ni	Co	Fe	Al_2O_3	CaO	MgO	SiO_2	Loss on ignition.	Cr_2O_3
Fathma	Poro, East Coast	?	6.51—(Ni & Co)		9.32	1.20	traces	16.36	49.60	?	?
Houailou	" "	?	4.84	....	10.63	0.52	"	22.16	45.64	10.78	1.40
Circé	Between Thio and Nakéty	?	6.97	....	10.20	1.27	"	17.40	50.62	?	?
Elise	Thio	26.61	6.80	....	11.92	1.30	"	19.30	38.52	?	?
Prises Alma & Rivoa	Port Bouquet E. Coast	22.86	6.46	0.13	12.81	0.20	"	21.95	36.82	?	1.20
" "	" " "	23.79	6.77	0.10	12.21	0.62	"	26.30	34.72	?	1.20
Puy. de Dome & Lucie	S." " "	?	6.47—(Ni & Co)		Fe_2O_3 & Al_2O_3	16.79	?	27.89	35.78	12.09	*
Etoile du Nord	Massif Kaala, W. Coast	22.53	6.82—(Ni & Co)		12.51	0.63	......	22.39	38.74	....	
Nouvelle - Espérance	Massif Ouazangou W. Coast	26.30	6.78—(Ni & Co)		12.27	1.42	......	23.19	39.76	....	
Mines de Voh	Massifs Katepahie & Koniambo	22.60	6.67	0.13	13.83	0.77	......	21.11	42.10	....	
Kataviti'	West Coast	23.91	6.19	0.10	9.10	0.73	......	24.18	41.20	....	1.24
"	" "	24.00	5.71	0.12	9.95	0.77	......	23.91	45.88	....	
Annie	Massif du Kongouhaou	?	7.74—(Ni & Co)		12.18	0.73	......	18.02	47.79	....	*
Souza	Region Dumbéa	?	5.45	?	12.65	1.42	......	23.26	38.56	....	*
Monnaie	" "	?	4.68	?	9.44	1.07	......	20.43	46.69	9.08	0.60
						1.10	......	18.90	49.98	9.30	0.57
Gracieuse	" "	27.50	7.26	0.15	11.10	0.41	......	27.03	36.90	8.95	1.38
Le Pic	" "	26.04	6.35	0.11	12.59	1.24	0.08	24.21	37.75	10.30	0.60
Barbouilleurs	" "	?	6.67—(Ni & Co)		13.58	1.17	......	15.40	48.60	....	
Tip Top	" "	?	4.75—(Ni & Co)		12.38	1.28	......	29.43	35.11	10.23	1.47
Tamanou	Cié Bay, S. of Island	?	5.93—(Ni & Co)		11.15	0.59	......	27.38	34.73	14.10	......
					11.55	0.53	......	28.51	34.59	16.02	....

With the exception of the uncombined water, the analyses represent the composition of the ores after drying at 100° C. Leaner ores are mixed with richer to produce a material for shipping that contains about 6 per cent. of nickel. Garnierite varies greatly in composition owing to mutual replacement of nickel and magnesium.

† From Report of Roy. Ont. Ni. Com., 1917, p. 248.

* Comprised in SiO_2.

serious rival. This illustrates sufficiently the importance of the lateritic nickel deposits of the island colony.

During recent years, under normal conditions, the annual output of New Caledonia was between 5,000 and 6,000 tons of metallic nickel. In 1916 Sudbury produced 41,000 tons, an abnormally high output due to demands created by the war.

Nickel Mine at Dumbéa, New Caledonia.

Cobalt Ores

The lateritic cobalt ores of New Caledonia occur under the same conditions as do manganese ores of India, of similar origin, described by Fermor and others. While the cobalt ores are of indefinite composition, the name asbolite is usually applied to them. The metals cobalt and manganese are carried downward in solution and, in certain cases, through some little understood cause, finally segregate into nodules and irregular veins or veinlets in the mass of the laterite. In so far as the author observed, deposits of laterite that are worked for nickel in New Caledonia have not been worked for cobalt, although deposits of both metals in some places occur close together, as at Poro on the east coast of the island. Cobalt is becoming of increasing importance as a constituent of alloy steels, and probably the deposits of the metal in New Caledonia will again become of economic value, especially as those of Cobalt, Ontario, are of decreasing importance.

The following analyses of New Caledonia cobalt ores are taken from E. Glasser's report.[1] They show the variable composition of the ores.

[1] Richesses Minérales de la Nouvelle-Calédonie, Paris, 1904.

TABLE No. 3

Analyses of New Caledonia Cobalt Ores

	1	2	3	4	5	6
SiO_2	50.75	32.00	34.00	16.40	2.20	23.09
Fe_2O	11.50	20.00	11.43	15.50	8.91	16.16
Mn_3O_4	14.00	26.50	19.05	12.07	33.62	17.59
Al_2O	....	....	....	14.60	11.29	10.50
MgO and CaO	14.50	3.66	....	....	2.38	2.23
CoO	2.50	3.50	3.80	3.60	7.76	5.56
NiO	....	....	1.04	1.48	1.64	1.18
Water, etc., loss on ignition	6.80	15.50	30.68	36.95	29.20	23.69

Iron Ores

While lateritic iron ores have been smelted in small primitive furnaces in India and elsewhere for a long period, it was only with the discovery of the true character of the Cuban deposits and their development that ores of this class came to receive due attention. In three or four areas in Cuba that have been carefully examined there are estimated to be a total of at least 3,000,000,000 tons of merchantable ore which can be mined by steam shovel methods. In the present workings the ores are mined to an average depth of about 19 feet. In addition to their mode of occurrence and origin, these ores are of interest owing to their containing two metals, nickel and chromium, of great importance in alloy steels. The composition of the ores is shown in table No. 1. Shipments of these ores to the United States began early in 1910. The nodulized or dehydrated ore averages: Fe 55-56 per cent., Ni 1-1.2, Cr about 1-2, SiO_2 1-1.1, Al_2O 11-11.5, absorbed water 3-3.5.

More recently large deposits of ores of similar character and origin have been discovered in Borneo, island of Seboekoe, where the quantity is estimated to be at least 300,000,000 tons. One of the Philippine Islands, Mindanao, has deposits of even greater size, 400,000,000 tons or more, the character of which was not recognized till 1911.[1]

While lateritic iron ores have now been proved to be of great economic importance, it is interesting to note that scarcely more than a decade ago those of a country as accessible as Cuba lay with their importance unrecognized. The character of the small nodules of ore that are found at the surface of the deposits was known, but the "red earth" with which they were associated was thought to be clay. Almost by accident the "clay" was discovered to be valuable iron ore.

Lateritic iron ores of the character of those of Cuba are to be looked for in every tropical country where basic rocks have been subjected to prolonged weathering. These ores are destined to play a very important part in the iron industry.

The percentage of combined silica in the Cuban deposits, whether they are of the nature of laterites, as defined by Fermor, or whether they are of the nature of ochre, ferruginous clay, was for a time of great legal importance. The title to the lands, which had been applied for or denounced as iron ore deposits, depended on whether the ores were true iron ores or whether they were ochres

[1] See Report Royal Ont. Ni. Commission for summary of the literature on iron ores of the three countries mentioned.

ch[illegible] Evidence that the deposits contained little combined silica, largely confirmed the titles of those who had denounced the deposits as iron ores against those who had denounced them as ochres.

The following table shows the character of the ore at various depths, in the Mayari area:

TABLE No. 4

Chemical Analyses Showing Alteration of Serpentine Rock to Iron Ore in the Mayari District, Cuba.[2]

Analyses supplied by Spanish-American Iron Co.

Depth, Feet	SiO_2	Al_2O_3	Fe_2O_3	Fe	MgO	Cr	Ni+Co	P	S	H_2O+	Total
0– 1	2.58	15.71	66.20	46.37	....	0.92	0.38	0.016	0.12	10.20	96.126
1– 2	2.38	20.81	64.70	45.34	....	0.96	0.33	0.022	0.12	10.63	99.952
2– 3	1.60	17.43	68.40	47.81	....	0.96	0.42	0.018	0.14	9.15	98.118
3– 4	1.42	14.23	68.70	48.09	....	1.04	0.36	0.019	0.16	9.50	95.429
4– 5	1.56	8.47	70.60	49.46	....	1.27	0.61	0.016	0.17	10.14	92.836
5– 6	2.90	10.24	72.35	50.56	....	1.66	0.84	0.016	0.20	10.96	99.166
6– 7	2.20	8.29	72.90	51.00	....	2.19	1.09	0.007	0.19	11.35	98.217
7– 8	2.68	4.92	71.85	50.28	....	2.19	1.15	0.006	0.14	11.57	94.506
8– 9	3.30	7.25	71.55	50.15	....	2.39	1.14	0.006	0.16	12.12	97.916
9–10	2.44	6.91	72.40	50.63	....	2.08	1.21	0.005	0.16	12.35	97.555
10–11	2.42	6.31	71.40	49.94	....	2.00	1.36	0.005	0.14	12.40	96.035
11–12	2.72	7.05	70.55	49.46	....	2.08	1.31	0.004	0.15	12.40	96.264
12–13	2.56	6.77	70.20	40.08	....	1.62	1.37	0.004	0.10	13.50	96.124
13–14	2.52	6.23	70.55	49.46	....	1.85	1.41	0.005	0.14	13.12	95.825
14–15	2.76	6.58	71.85	50.22	....	1.89	1.38	0.007	0.21	12.45	97.127
15–16	2.78	6.53	70.00	48.98	....	2.16	1.33	0.007	0.19	12.35	95.347
16–17	2.98	6.43	69.80	48.84	....	2.19	1.42	0.007	0.19	12.57	95.587
17–18	3.20	5.53	70.45	49.32	....	2.00	1.35	0.007	0.15	12.90	95.587
18–19	3.66	6.51	69.20	48.42	....	2.43	1.34	0.005	0.06	12.73	95.935
19–20	6.84	8.49	63.35	44.32	....	2.51	1.36	0.004	0.08	12.80	95.434
20–21	7.44	5.13	66.55	46.58	....	2.27	1.57	0.003	0.09	12.45	95.503
21–22	8.46	4.99	57.80	40.47	0.00	2.16	1.47	0.006	0.08	12.71	87.676
22–23	11.04	8.38	62.10	43.49	0.00	1.85	1.74	0.002	0.09	14.07	99.272
23–24	15.86	4.70	63.90	44.62	0.00	2.19	1.57	0.003	0.09	11.73	100.043
24–25	17.40	4.00	62.90	40.00	0.50	1.85	1.43	0.003	0.12	11.64	99.843
25–26	22.54	4.57	50.25	35.12	6.49	1.89	1.80	0.002	0.06	13.65	101.252
26–27	28.60	4.18	32.85	23.00	18.23	1.12	1.43	0.003	0.09	13.45	99.953
27–28	35.64	2.33	18.25	12.78	27.35	0.77	1.35	0.001	0.06	14.23	99.981
28–29	39.80	1.39	10.14	7.10	33.69	0.20	0.97	0.001	0.06	13.31	99.561

Manganese Ores

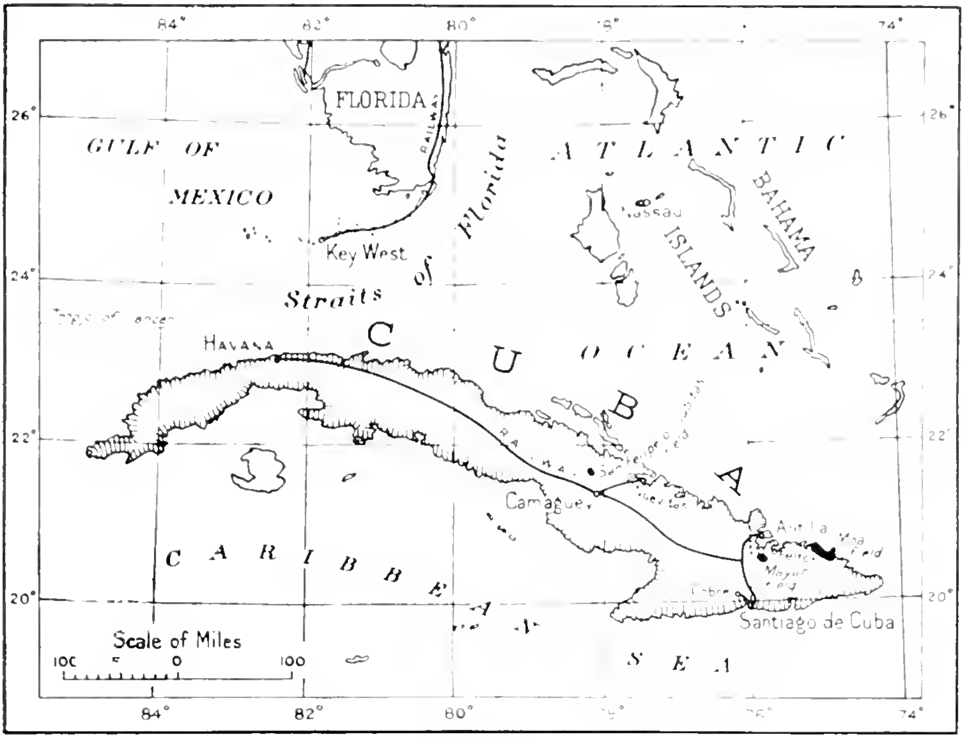
Laterite manganese ores of India, although of much less importance than ores of the metal of other origin, are of much interest. Their mode of occurrence is similar to that of the cobalt ores of New Caledonia.

Fermor says: . . . . manganese, when present in laterite, usually renders itself conspicuous by segregating into forms, as a rule black nodules or veins of psilomelane or pyrolusite, that one would without any hesitation call manganese-ore. It rarely seems, except in very small quantity (or in proper manganese-ores), to become blended with the other constituents of laterite, so as to form intimate mixtures similar to those that the oxides of iron, aluminum, and titanium, so commonly form with one another. Indeed, many large masses of laterite can be found . . . . that seem to be completely free from manganese. As it cannot be supposed that the rocks from which the iron and alumina of the laterite were derived contained no manganese, it is necessary to suppose that with solutions containing manganese, iron, and aluminum, a selective precipitation can take place in nature.[3]

[1] The Mayari and Moa Iron Ore Deposits of Cuba, A.I.M.E., Vol. XLII, pp. 109-115.
Characteristics and Origin of the Brown Iron-Ores of Camaguey and Moa, Cuba, Ibid., pp. 116-137.

[2] Additional data on origin of Lateritic Iron Ores of Eastern Cuba, C. K. Leith and W. J. Mead, A.I.M.E., Vol. LIII, 1915, p. 76.

[3] Memoir, Geol. Surv. India, Vol. XXXVII, p. 381.



Map of Cuba.

The following table of analyses is taken from Fermor's report.[1]

TABLE No. 5

Analyses of Lateritic Manganese Ores

	Belgaum	SHIMOGA Higher grade ores	SHIMOGA Lower grade ores	Sandur
Manganese	31.2 -60.8	44-56	30-38	39.47-54.39
Iron	0.1 -18.4	2-10	10-20	5.38-19.40
Silica	0.6 - 2.5	1- 3	2- 6	0.43- 1.00
Phosphorus	0.01- 0.12	0.015-0.600	0.01- 0.6	0.016-0.033

[1] P. 389.

The situation as regards manganese, especially in the United States, is now serious, and is likely to continue so long as the war lasts. By far the most important producers of manganese ores are Southern Russia, British India and Brazil. As is the case of nickel, a very few countries supply the greater part of the world's requirements for manganese.

Aluminum Ores

That in India extensive deposits of bauxite, the chief ore of aluminum, are of lateritic origin is seen from the following:

Some years ago it was discovered that many of the lateritic deposits of India are highly aluminous, such aluminous varieties being identical with the substance known as bauxite. Field-work carried out since 1903 by the officers of the Geological Survey has revealed the existence of extensive deposits of this mineral substance in various parts of India, and chemical investigation in the Geological Survey Laboratory and at the Imperial Institute has shown that certain of the Indian bauxites compare very favourably with the Irish, French, and American bauxites placed on the English market. . . . Eight analyses of specimens and samples of the Balaghat bauxites have given results ranging between the following limits:—

Al_2O_3	51.62 to 58.83
Fe_2O_3	2.70 to 10.58
TiO_2	6.22 to 13.76
SiO_2	0.05 to 2.65
Combined water	22.76 to 30.72
Moisture	0.40 to 1.14

Corresponding to 71.2 to 80.8 per cent. of Al_2O_3 after calcination. With these may be compared the following figures showing the range of analysis of some Irish, French, and American bauxites of commerce analysed at the Imperial Institute:—

Al_2O_3	42 to 63
Fe_2O_3	2 to 21
TiO_2	2 to 6
SiO_2	3 to 13
H_2O	12 to 28
Moisture	5 to 16

Two Katni bauxites gave the following analyses:—

	No. 1	No. 2
Al_2O_3	65.48	52.67
Fe_2O_3	3.77	7.04
TiO_2	11.61	7.51
SiO_2	0.38	1.26
H_2O	19.38	29.83

From these figures it will be seen that the Balaghat and Jubbulpore bauxites are of very high grade. There seems also to be little doubt that large quantities of the mineral are available, and the commercial feasibility of making use of these deposits has consequently been under investigation for some years.[1]

While not dealing specifically with the character or origin of laterites, W. J. Mead[2] in his paper on the "Occurrence and Origin of the Bauxite Deposits of Arkansas," furnishes data that make the attempt to define and classify laterites still more difficult. It will be seen from the following notes from Mead's paper that the bauxite is a product of weathering of nephelene syenite. Moreover, the analyses show that the upper layers of the deposits, formed in situ, are to be

[1] Records Geol. Surv. of India, Vol. XLVI, 1915, pp. 228, 229.
[2] Ec. Geology, 1915, pp. 28-54.

classified as clays, while lower layers, with their high content of bauxite and low percentage of silica, according to the definitions proposed by most writers, are to be classed as laterites. These bauxite-holding deposits, therefore, considered as a whole, cannot be classed as either laterite or clay.

Mead says: It appears that normal weathering of the syenite to kaolin and allied minerals has simply continued one step further in breaking down these hydrous aluminum silicates to hydrous aluminum oxide.

Downward Secondary Enrichment of Alumina

The top portion of the bauxite deposits is characteristically higher in silica than the bauxite below. In many instances it has been necessary to remove the upper eighteen inches or two feet of high silica ore before mining, thus adding greatly to the mining cost. A typical instance is shown in the following table of analyses of a series of samples from a test pit in bauxite.

TABLE No. 6

Marked.	SiO_2	Fe_2O_3	TiO_2	Loss on ignition.	Al_2O_3 by Diff.
3′ – 5′	24.85	4.84	1.3	22.97	46.04
5′ – 8′	13.54	3.44	1.5	27.52	54.30
7′ – 9′	14.63	3.24	1.5	28.22	52.41
9′ –11′	7.73	2.63	1.3	30.36	57.98
11′ –13′	9.96	3.19	1.4	29.04	56.41
13′ –15′	9.65	1.59	1.7	29.89	57.16
15′ –17′	9.00	2.99	1.6	29.56	56.76
17′ –19′	13.29	2.32	1.8	27.69	54.90
19′ –21′	11.88	2.11	1.8	28.44	55.77
21′ –23′	7.08	2.57	2.0	30.25	58.09
23′ –25′	6.84	2.02	1.7	29.91	59.53
25′ –27′	7.33	3.04	1.7	30.63	57.30
27′ –29′	5.52	2.16	2.8	30.69	58.83
29′ –31′	5.70	2.11	1.9	30.53	59.76

This increase in silica toward the surface may be due to an actual downward secondary concentration of alumina. Those portions of kaolin and halloysite which persist after the main portion of the kaolinized syenite has been altered to bauxite are the dense impervious parts. Bauxite is soluble in surface solution to a certain extent, and on being dissolved and carried downward leaves the kaolin and hence the silica in relatively higher percentage at the surface. The alumina carried down is deposited below, assisting in the formation of the pisolites.

Various writers on the geology of India have shown the wide distribution of bauxite in that country and have emphasized the fact that bauxite is a variety of laterite. That the deposits of Arkansas are of great importance is shown by the fact that over 80 per cent. of the large production of bauxite in the United States, during the five years up to 1915, came from that State.

Gold Ores

Among the most interesting descriptions of lateritic gold deposits are those of British Guiana by J. B. Harrison.[1] The following quotations from this author show the character of the deposits.

[1] The Geology of the Goldfields of British Guiana, 1908.

The diabase intrusions occur in belts, generally stretching across the colony in a north-westerly and south-easterly direction. The intrusions vary from narrow dykes, only exposed in the courses of the rivers during very dry seasons, some being not more than from two to three feet across, to low hills and to mountain ranges, some of which—for example, the Eagle mountains in the Potaro gold district—exceed in height two thousand feet. The tops and sides of the hills and mountains, except where they have suffered great denudation, are covered with ironstone gravel, while the lower parts of the districts in which diabase forms the country are covered up with strata of laterite, frequently over one hundred feet in depth, and in places interspersed with nests of secondary quartz, or traversed by veins and stringers of quartz, or, less often, by lenticular layers of secondary quartz, closely resembling, when cut through by mining shafts, tunnels and trenches, true quartz-reefs. The quartz rock in all these forms is not unfrequently auriferous, the metal being dispersed through it in a very irregular manner, especially in the larger lenticular layers, which in many parts are nearly or even entirely, barren of gold, and in others are "bonanzas" carrying at rates from twenty to, in places, several hundreds of ounces of the precious metal to the ton of the rock. Unfortunately hitherto these bonanzas have proved few and far between; but there is no reason for assuming that they will not be found in many places in the enormous area of the laterite deposits which up to the present has not been prospected, as they have been in similar places at intervals in the past. Gold also occurs as paint gold, as gold dust, and as nuggets of varying sizes in the laterite.[1]

No quartz veins occur in the diabase, whilst in the unaltered epidiorite and hornblende-schist only, as a rule, narrow veins and stringers of quartz are found. But veins and lenticular masses of quartz which are, not unfrequently, rich in gold are of common occurrence in the decomposition-products of the epidiorite, hornblende-schist and diabase.[2]

Where the country rock traversed by these veins has decomposed to a great depth their size has been largely increased, having been added to by silica dissolved from the decomposing rocks by percolating waters. At the same time as silica was thus deposited a concentration and deposition of the gold contained in the decomposing rocks took place, and thus the quartz veins became enriched in this metal in proportions varying with those present in the country rock, with the result that the veins found in decomposed epidiorite and hornblende-schist are, as a rule, richer in gold than are those found in decomposed acidic rocks.[3]

The veins of quartz which traverse the dark-red decomposition-products of the basic rocks are frequently very rich in gold at and near their outcrops, these parts being far more auriferous than are the remaining portions of the veins. Similarly the talcose selvages of these veins are often highly auriferous.[4]

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[1] The Geology of the Goldfields of British Guiana, 1908, pp. 22, 23.

[2] Ibid., p. 186.

[3] Ibid., pp. 186, 187.

[4] Ibid., p. 187.

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XCV
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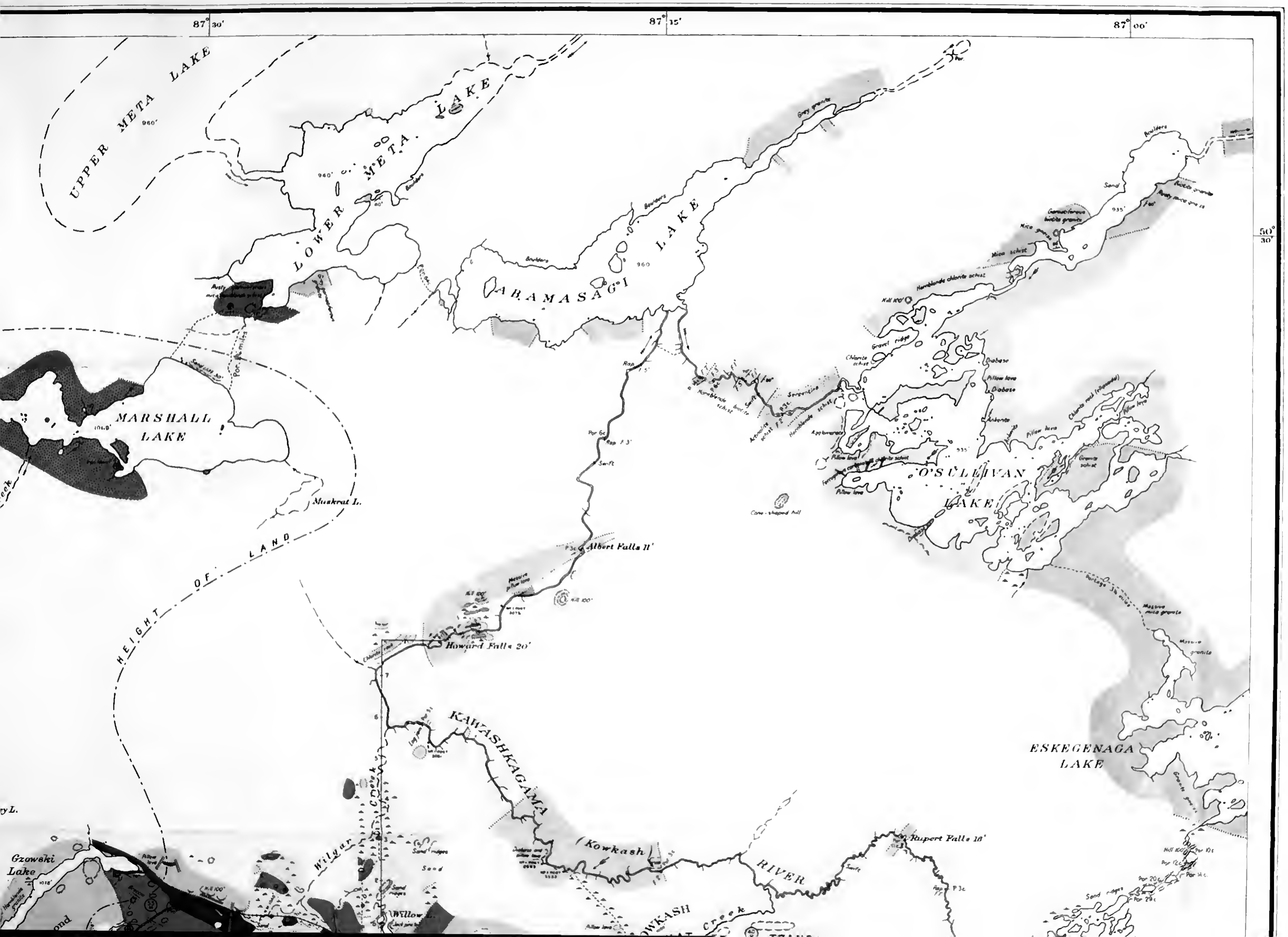
Howard Falls 20'
Willow L.
Granite and gravel hills
Grey granite
Hornblende biotite granite
Diabase and pillow lava schist
Massive pink biotite granite
Massive pink mica granite



NOTES

One edition of this map on a scale of 4 miles to the inch, based on a compilation of existing maps and supplemented by two weeks' field work in the Autumn of 1915, has been published. The present edition is based on field work in 1916, but owing to much of the time being devoted to topography, the complicated pre-Cambrian geology was slighted to some extent. The solid lines on the water routes represent actual surveys while the broken lines are simply sketches. The lengths of the portages have been marked in chains (66 feet).

The Kowkash gold area is situated in the central part of the district of Thunder Bay, Ontario, immediately northeast of lake Nipigon, and is traversed by the National Transcontinental railway. Kowkash and Tashota, the principal stations, are situated 297 and 319 miles respectively west of Cochrane, which is located 481 miles by railway north of Toronto. Upon completion of the National Transcontinental railway through the region in 1913 the country became commercially important and easily accessible to prospectors. In August, 1915, spectacular gold was discovered by E. W. King-Dodds near Howard falls, 9 miles north of Kowkash. As a result, prospectors rushed to the area and other gold finds were made along the Kowkash river and in the vicinity of Tashota. For the convenience of prospectors a new mining division called the "Kowkash Mining Division" was formed and a mining recording office established at Tashota in June, 1916.

The area has an average altitude of about 1,000 feet above sea level. Flat topography is general, particularly in the northeastern part where hills seldom rise more than 50 feet above the surrounding country. However, hills may attain an elevation of 200 or 300 feet above the adjacent valleys in the more rugged sections which are located in the south and west parts of the map sheet. The average magnetic declination along the meridian forming the east boundary of the Nipigon Forest Reserve, when surveyed in 1916, was 0°45' west.

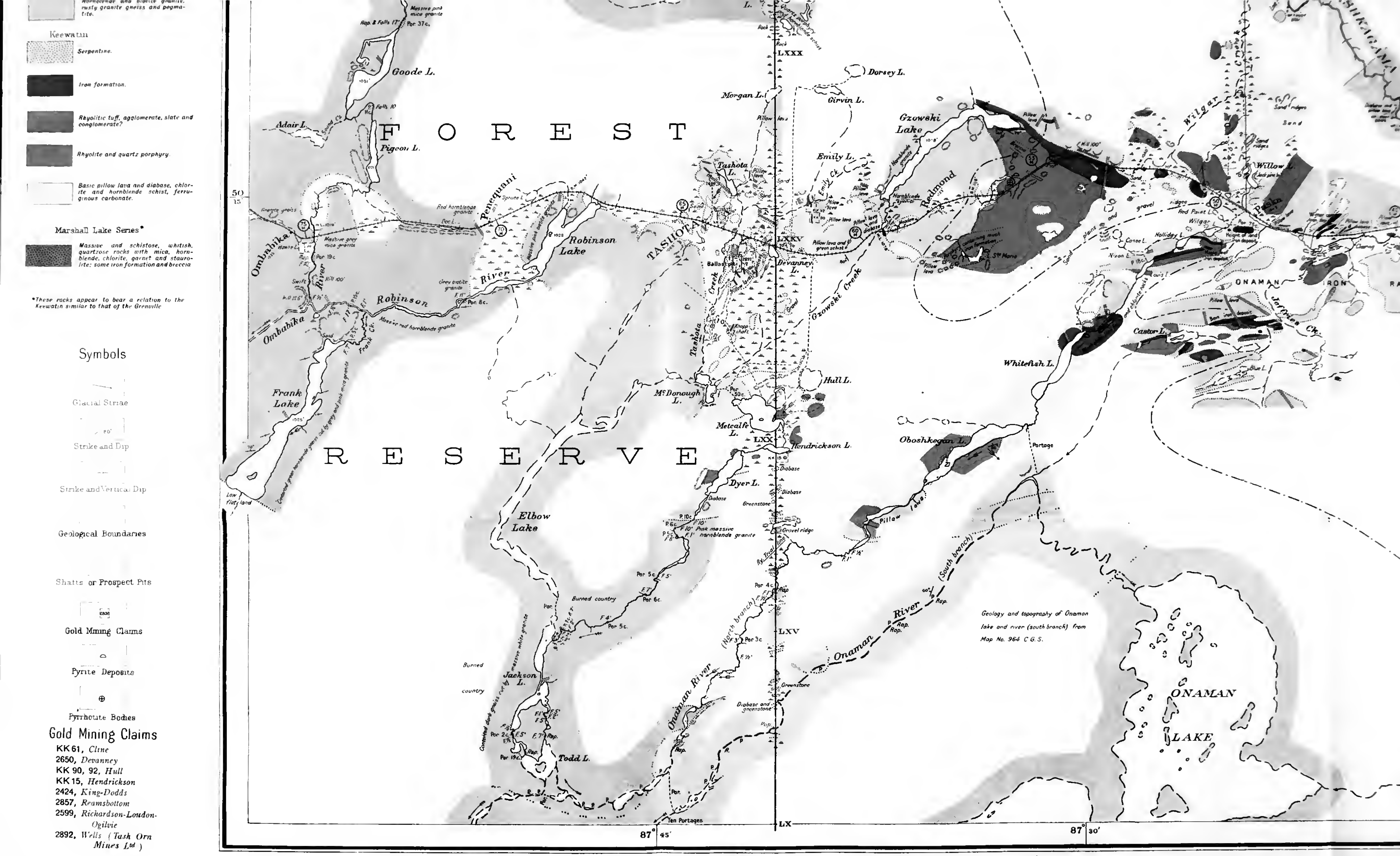
GEOLOGY.

An attempt has been made to outline the rock exposures, the uncoloured parts representing areas not examined. The legend accompanying the map gives the rock relationships.

Keewatin:—The oldest rocks of the area consist dominantly of highly altered basic and acid extrusives. Originally these were probably basalt, diabase, rhyolite, etc. Greenstones showing the pillow structure can be seen along various parts of the railway between Tashota and Gzowski creek. The white weathering rhyolites and quartz porphyries occur in large volume across the south central part of the area. A typical sample may be seen immediately north of Paska, while a grey cherty variety occurs at mileage 50½ on the railway. Accompanying the rhyolites are considerable volumes of rhyolite-tuff, agglomerate, slate, conglomerate (?), iron formation and ferruginous carbonates (ankerite and dolomite), all of which were probably deposited in the same water basin. The serpentine is probably an altered peridotite.

Marshall Lake Series:—Associated with the Keewatin and probably of the same age is a large volume of metamorphic rocks consisting dominantly of whitish quartzose mica schists alternating with subordinate amounts of hornblende-, garnet- and staurolite-quartz schists. The rocks appear to be largely clastics, or volcanic fragmental rocks deposited in water, these having been intruded, in places, by some light-coloured, similar-looking rocks.

Laurentian ?—Cutting these older rocks are batholiths and bosses of granite, gneiss and allied types. The gneiss occurs in subordinate amounts and resembles the Laurentian in other parts of the Province. Over 75 per cent. of these acid rocks are of the massive fresher types, resembling the Algoman. Numerous narrow dikes of quartz porphyry, probably apophyses from granite, occur in the vicinity of Tashota and Howard falls, while an occasional dike may be seen in other parts. These intrusions are



Hornblende and biotite granite, rusty granite gneiss and pegmatite.
Keewatin
Serpentine.
Iron formation.
Rhyolitic tuff, agglomerate, slate and conglomerate?
Rhyolite and quartz porphyry.
Basic pillow lava and diabase, chlorite and hornblende schist, ferruginous carbonate.
Marshall Lake Series*
Massive and schistose, whitish, quartzose rocks with mica, hornblende, chlorite, garnet and staurolite: some iron formation and breccia
*These rocks appear to bear a relation to the Keewatin similar to that of the Grenville
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Strike and Dip
Strike and Vertical Dip
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Gold Mining Claims
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Onaman
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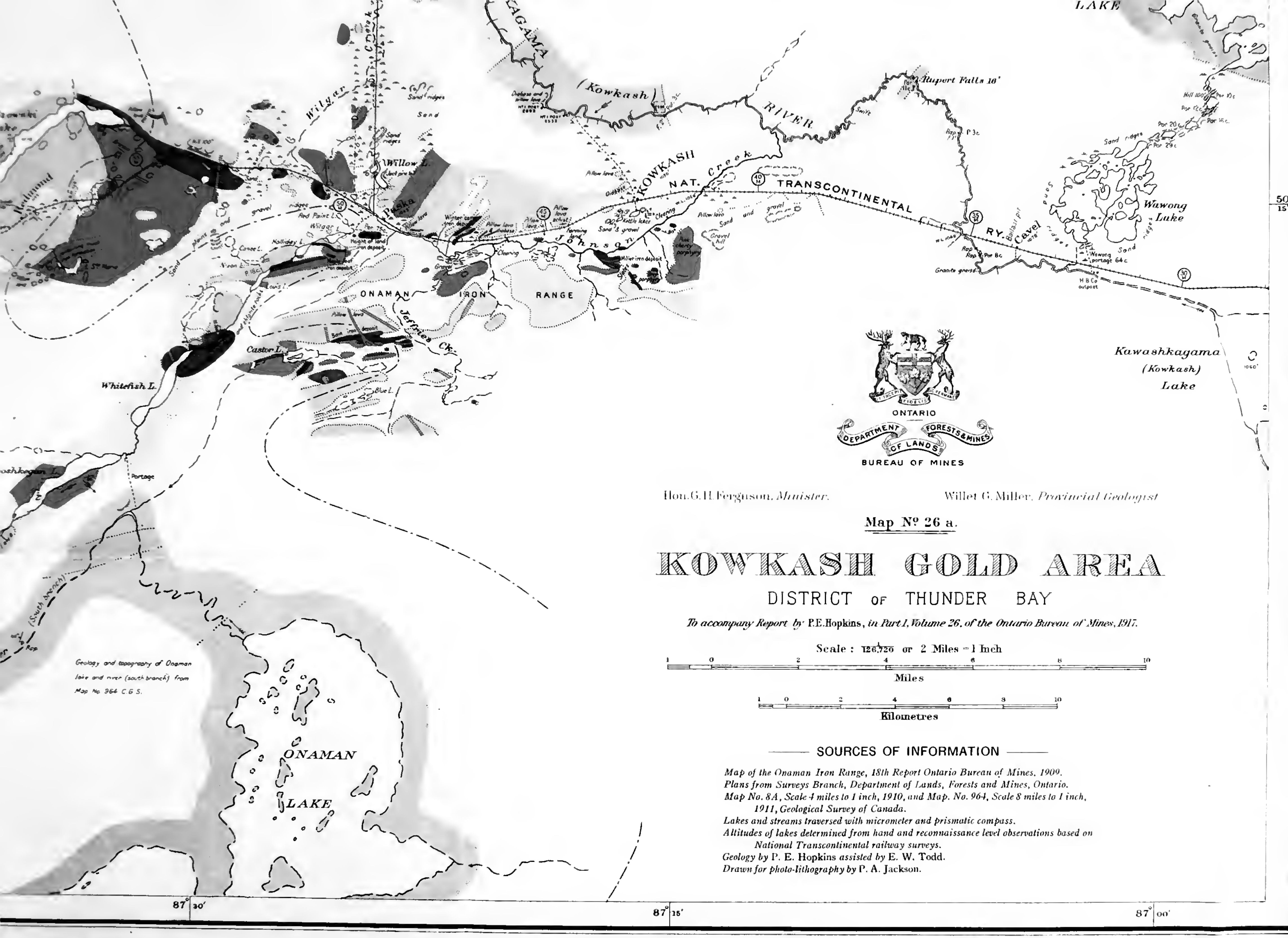
Nixon L.
Ten Portages
Portage
LXXX
LXXV
LXX
LXV
LX
87° 45'
87° 30'
50° 15'
Geology and topography of Onaman lake and river (south branch) from Map No. 964 C.G.S.



Joins Map No. 26b.

First Edition (Map No. 25a), 1916.
Second Edition (Map No. 26a), 1917.

Keewatin and probably of the same age as a large volume of metamorphic rocks consisting predominantly of whitish quartzose mica schists alternating with subordinate amounts of hornblende-, garnet- and staurolite-quartz schists. The rocks appear to be largely sheared volcanic fragmental rocks deposited in water, these having been intruded, in places, by more light-coloured, similar-looking rocks.

Laurentian?—Cutting these older rocks are batholiths and bosses of granite, gneiss and allied types. The gneiss occurs in subordinate amounts and resembles the Laurentian in other parts of the Province. Over 75 per cent of these acid rocks are of the massive fresher types, resembling the Algoman. Numerous narrow dikes of quartz porphyry, probably apophyses from granite, occur in the vicinity of Tashota and Howard falls, while an occasional dike may be seen in other parts. These intrusions are important since they usually occur near the gold-bearing quartz veins.

Timiskamian?—Two small exposures of conglomerate slate and greywacké schist, with the bedding in a vertical attitude, occur on the northeast arm of Cross lake and on the Kowkash river below Howard falls. Granite gneiss pebbles were noted in the conglomerate on the Kowkash river while the pebbles in the conglomerate at Cross lake consist chiefly of mica-quartz schist resembling the Marshall Lake series.

Keweenawan?—Quartz diabase, the youngest rock of the area, is classed as Keweenawan.

ECONOMIC NOTES

Gold.—Gold, the chief mineral sought for at the present time, occurs in quartz veins in Keewatin green schists which have been intruded by quartz porphyry dikes probably of Algoman age. The chief deposits occur in the vicinity of Tashota and Howard falls where the quartz porphyry intrusions are most pronounced. The gold usually occurs native in quartz veins which may also carry some of the following minerals: calcite, chlorite, tourmaline, biotite, pyrrhotite, pyrite, chalcopyrite, native copper, bismuthinite, molybdenite, graphite, fluorite or tellurides. Extensive trenching has been done, and some diamond drilling. Several shafts have been sunk on the deposits, the principal development work having been done on the Wells property near Tashota.

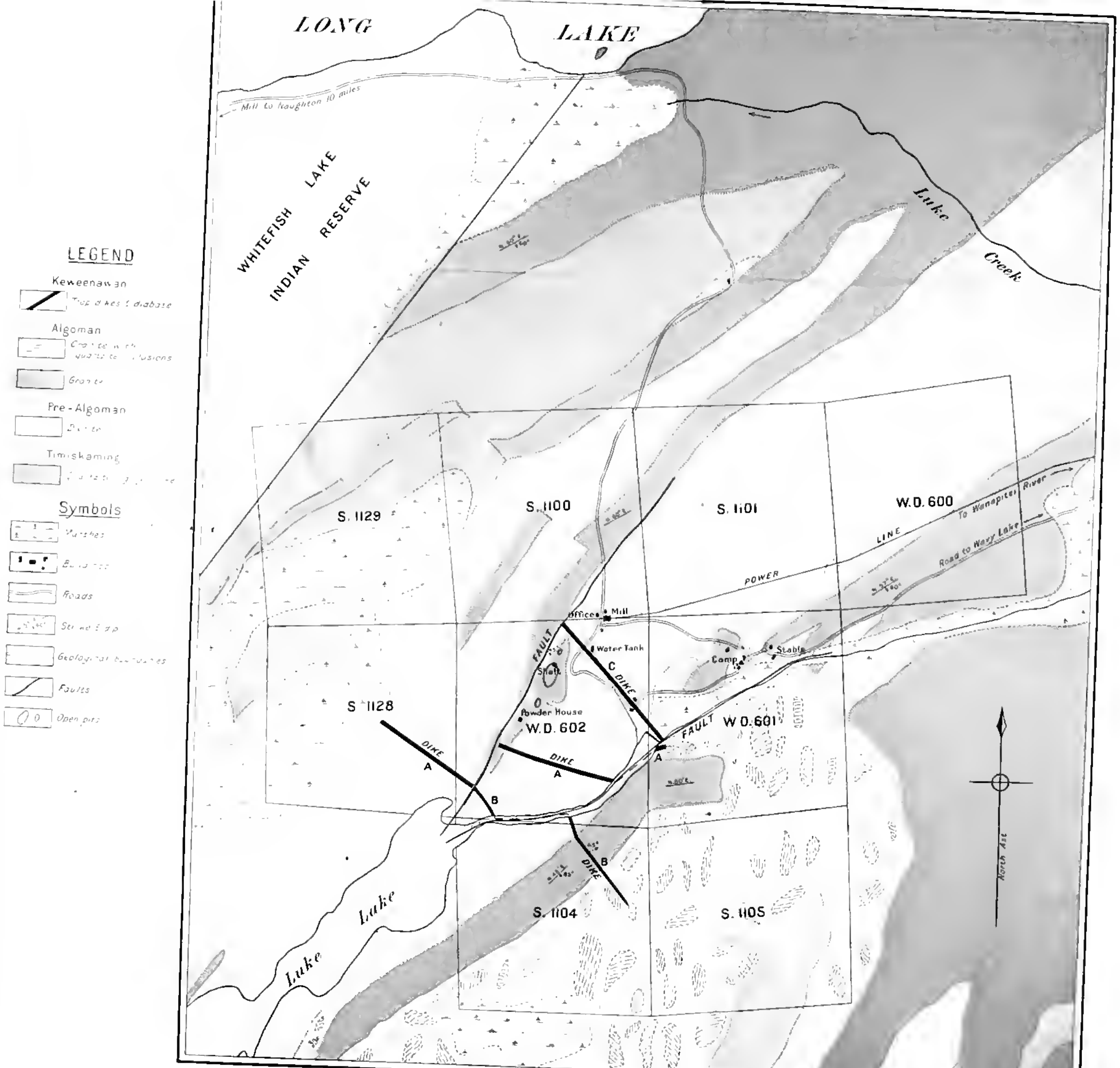
Iron.—In 1906 and 1907, before the construction of the railway, much prospecting was done for iron on the Onaman Iron Range which lies to the south and west of Kowkash station. The principal deposits, viz, Miller, Winter Camp, Height of Land, Maple Leaf and Bain are located on the map. E. S. Moore, who mapped the Iron Range in detail for the Bureau of Mines regards the easterly end of the Bain deposits as the most promising.

Iron Pyrites.—Several pyrite deposits were seen in the area, some of which warrant further exploratory work. Some of these had not been prospected while on others considerable trenching had been done. Their locations are indicated on the map while descriptions of them are embodied in the report.

Pyrrhotite.—In various parts of the area there are massive bodies of pyrrhotite whose locations are shown on the map. The deposits in the vicinity of Marshall lake, one of which is 20 feet wide, were prospected in 1912 and 1913 for platinum. Samples were collected from the various deposits but were found, on analysis, to contain no platinum, nickel or gold.

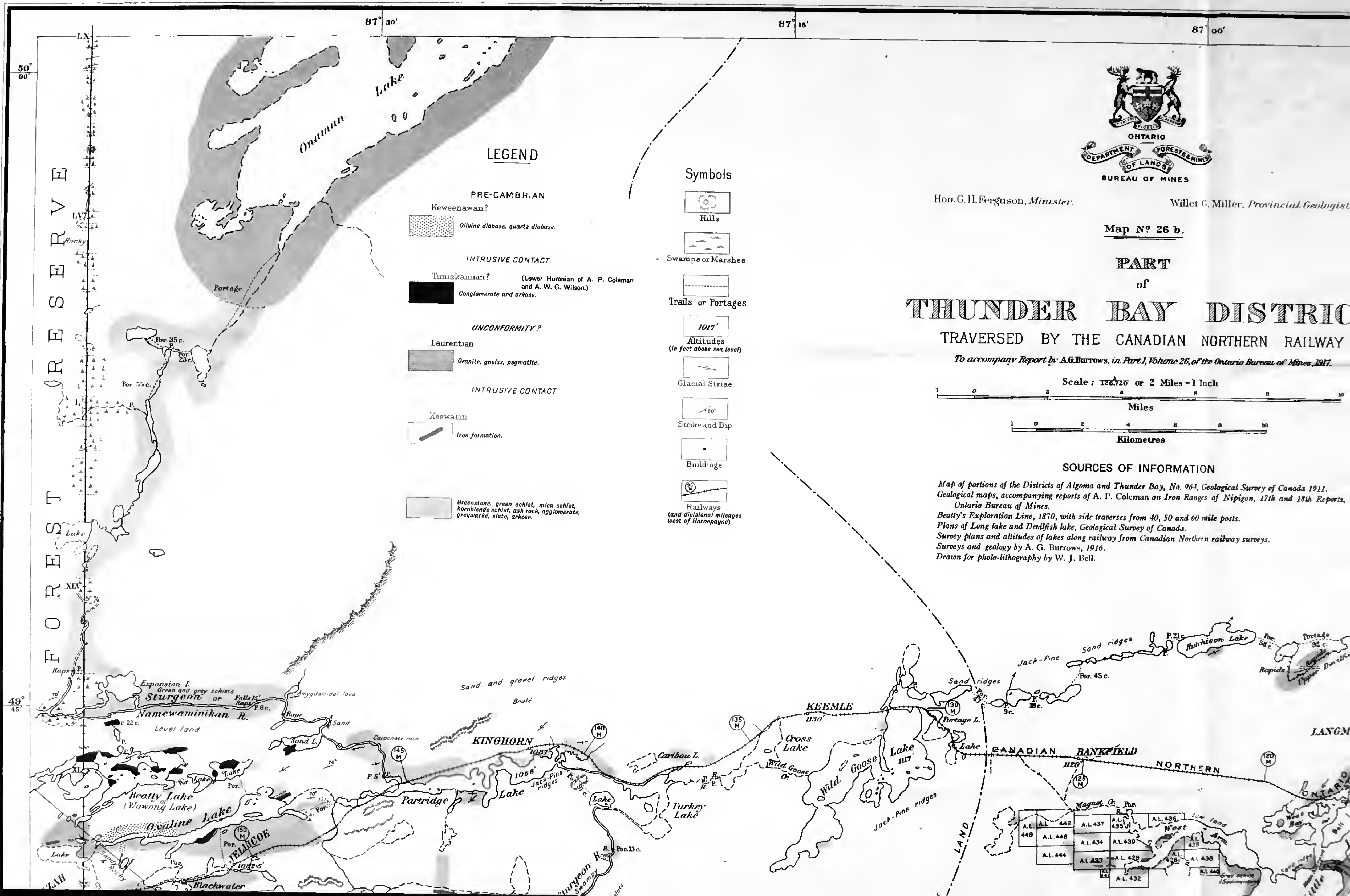
Building Stone.—The granites along the railway in the vicinity of mileages 57 and 71 are massive and jointed and appear to be of a quality suitable for building stone.

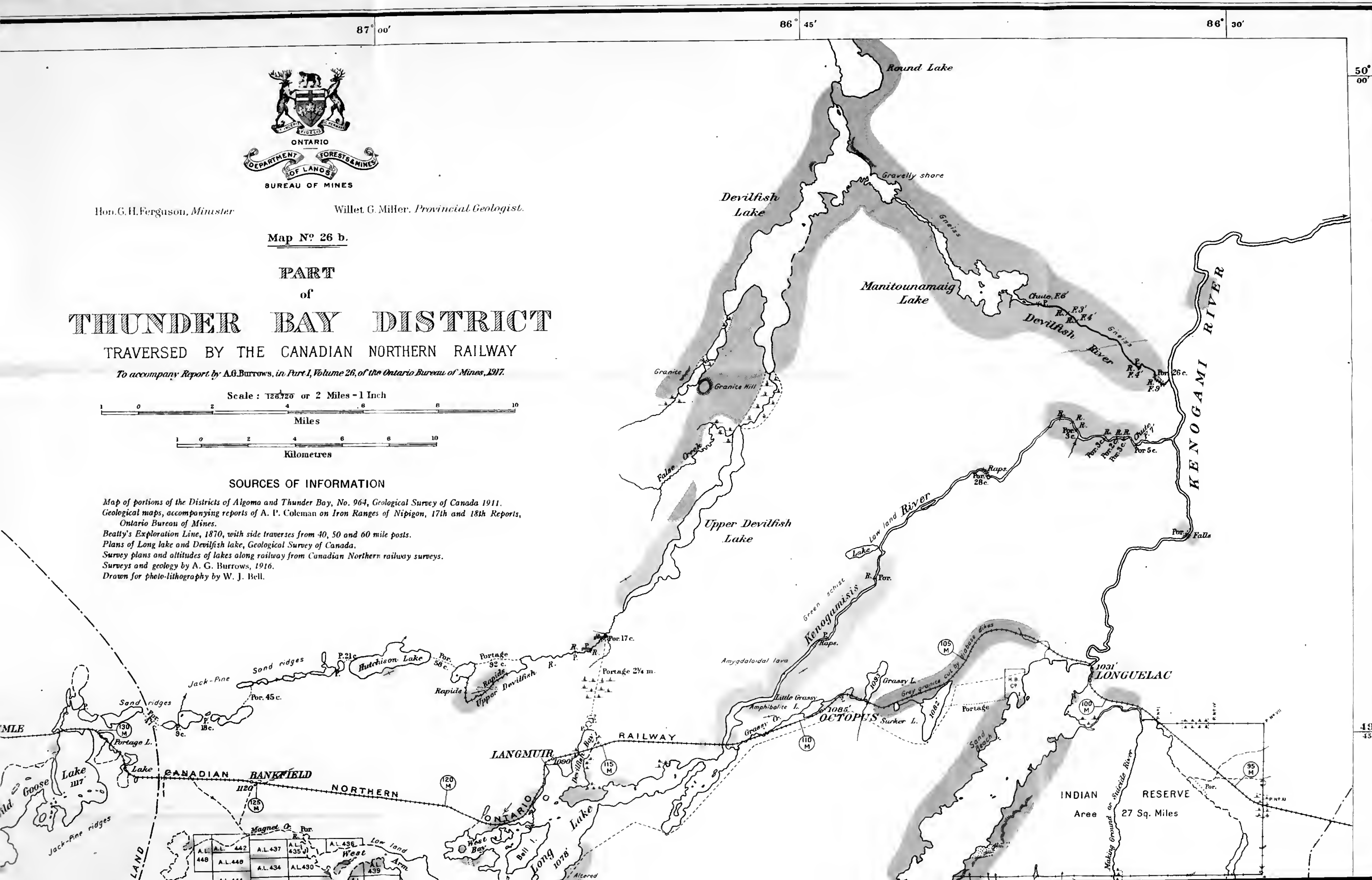
Travertine and Marl.—A deposit of soft, white calcium carbonate or travertine, at least 20 feet thick in places, occurs in Red Paint lake, one-half a mile from Paska. White shell marl occurs in a small pond one-half a mile to the southeast of the Tashota gravel pit.


LEGEND
Keweenawan
Algoman
Granite
Pre-Algoman
Timiskaming
Symbols
Roads
Faults
Open pits
LONG LAKE
Mill to Naughton 10 miles
WHITEFISH LAKE
INDIAN RESERVE
Lake Creek
S. 1129
S. 1100
S. 1101
W.D. 600
POWER LINE
To Wanapitei River
Road to Wavy Lake
Offices
Mill
Water Tank
Camp
Stable
Shaft
Powder House
FAULT
DIKE
W.D. 602
W.D. 601
S. 1128
S. 1104
S. 1105
Lake Lake
North Ast

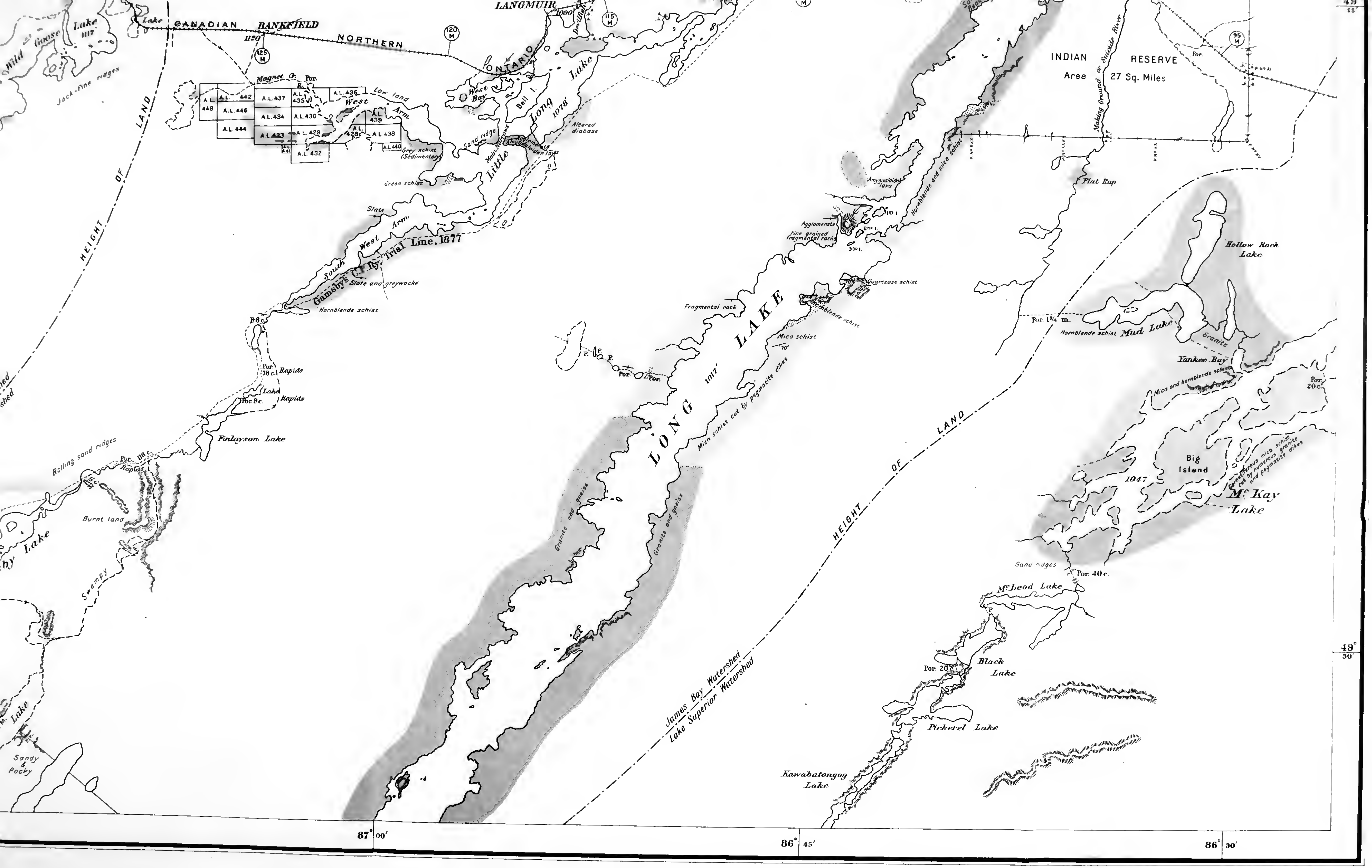
PROVINCE OF ONTARIO
DEPARTMENT OF MINES
HON. CHARLES McCREA, MINISTER OF MINES
T. W. Gibson, Deputy Minister, Consultant
T. F. Sutherland, Acting Deputy Minister
A. G. Burrows, Provincial Geologist

Joins Map No. 26a.




ONTARIO
DEPARTMENT OF LANDS FORESTS & MINES
BUREAU OF MINES
Hon. G. H. Ferguson, Minister
Willet G. Miller, Provincial Geologist.
Map No 26 b.
PART
of
THUNDER BAY DISTRICT
TRAVERSED BY THE CANADIAN NORTHERN RAILWAY
To accompany Report by A. G. Burrows, in Part I, Volume 26, of the Ontario Bureau of Mines, 1917.
Scale: 1/126,720 or 2 Miles = 1 Inch
Miles
Kilometres
SOURCES OF INFORMATION
Map of portions of the Districts of Algoma and Thunder Bay, No. 964, Geological Survey of Canada 1911.
Geological maps, accompanying reports of A. P. Coleman on Iron Ranges of Nipigon, 17th and 18th Reports, Ontario Bureau of Mines.
Beatty's Exploration Line, 1870, with side traverses from 40, 50 and 60 mile posts.
Plans of Long lake and Devilfish lake, Geological Survey of Canada.
Survey plans and altitudes of lakes along railway from Canadian Northern railway surveys.
Surveys and geology by A. G. Burrows, 1916.
Drawn for photo-lithography by W. J. Bell.
87° 00'
86° 45'
86° 30'
50° 00'
49° 45'
Round Lake
Gravelly shore
Devilfish Lake
Gneiss
Manitounamaig Lake
Devilfish River
KENOGAMI RIVER
Granite
Granite Hill
False Creek
Upper Devilfish Lake
Low land River
Lake
Green schist
Kenogamisis
Amygdaloidal lava
Grassy L.
Grey granite cut by diabase dikes
Little Grassy
Amphibolite L.
OCTOPUS
Surker L.
Sand Beach
LONGUELAC
Portage
INDIAN RESERVE
Area 27 Sq. Miles
Making Ground or Suicide River
Hutchison Lake
Sand ridges
Jack-Pine
Jack-Pine ridges
Portage 2¼ m.
Upper Devilfish R.
Rapids
RAILWAY
LANGMUIR
CANADIAN
BANKFIELD
NORTHERN
ONTARIO
Devilfish Bay
Long Lake
West Bay
Bell I.
Goose
Lake
Portage L.
Magnet Cr.
Low land Arm
West
LAND

Namewaminikan R.
Level land
KINGHORN
Cross Lake
Caribou L.
Wild Goose Cr.
Wild Goose Lake
CANADIAN NORTHERN
BANKFIELD
Beatty Lake (Wawong Lake)
Oxaline Lake
JELLICOE
Partridge Lake
Turkey Lake
Jack-Pine ridges
Magnet Cr.
West Arm
Blackwater Lake
Blackwater R.
Sturgeon R.
Namewaminikan or Sturgeon R.
Falls & Raps
Banded greywacke and slate
Light Rapids
Heavy Rapids
Level land
Burnt land
Swamp
Burnt
HEIGHT OF LAND
Lake Superior Watershed
James Bay Watershed
South West Arm
Gamsby's C.P.Ry. Trial Line, 1877
Slate and greywacke
Hornblende schist
Green schist
Rapids
Finlayson Lake
Rolling sand ridges
Burnt land
Gamsby Lake
Swampy
NIPIGON
EAST BOUNDARY OF RESERVE
(Surveyed by Phillips & Bennet, 1916)
Beatty's Exploratory Line, 1870
White Sand & Rock
Rocky land Slightly rolling
White Sand & Rock
Jack-Pine
Cabin Raps.
Rocky
Rolling rocky land
White sand & rock
Fecteau Lake
Sand & rock
White sand
Island Lake
Parks Lake
Granite
Sand Ridge
Burnt rolling land
High Shore
Granite Ridge
Margaret L.
Granite ridges
Portage 2 miles
Granite Lake
Sedge L.
Wintering Lake
Sand cliffs
Sandy rocky land Rolling
Rogers Lake
Sandy & Rocky
49° 30'
87° 30'
87° 15'
87° 00'



LANGMUIR
CANADIAN
BANKFIELD
NORTHERN
ONTARIO
Wild Goose Lake
Jack-Pine ridges
HEIGHT OF LAND
Magnet Cr.
West Bay
West Arm
Low land
Bell I.
Little Long Lake
1078'
Altered diabase
Sand ridge
Main Narrows
Amygdaloidal lava
Grey schist (Sedimentary)
Green schist
Slate
South West Arm
Gamsby's C.P.Ry. Trial Line, 1877
Slate and greywacke
Hornblende schist
Rapids
Finlayson Lake
Rolling sand ridges
Burnt land
Swampy
Sandy & Rocky
INDIAN RESERVE
Area 27 Sq. Miles
Making Ground or Suicide River
Flat Rap
Amygdaloidal lava
Hornblende and mica schist
Agglomerate
Fine grained fragmental rocks
Quartzose schist
Fragmental rock
Mica schist
LONG LAKE
1017'
Mica schist cut by pegmatite dikes
Granite and gneiss
Granite and gneiss
Hollow Rock Lake
Hornblende schist
Mud Lake
Granite
Yankee Bay
Mica and hornblende schist
Big Island
1047'
Garnetiferous mica schist cut by numerous granite and pegmatite dikes
McKay Lake
Sand ridges
Por. 40 c.
McLeod Lake
Black Lake
Pickerel Lake
Kawabatongog Lake
James Bay Watershed
Lake Superior Watershed
HEIGHT OF LAND
87° 00'
86° 45'
86° 30'
49° 30'